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CATECHISM OF THE LOCOMOTIVE.

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PART XII.

ADHESION AND TRACTION.

QUESTION 299. *What is meant by the "adhesion" of a locomotive?*

Answer. It is the resistance which prevents or opposes the slipping of the driving-wheels on the rails, and is due to the friction of the former on the latter.

QUESTION 300. *On what does the amount of this friction depend?*

Answer. Like all friction it depends upon the weight or pressure of the surfaces in contact, and consequently upon the load which rests on each wheel. It also depends upon the condition of the rails, and probably to some extent upon the material of which they and the tires on the wheels are made.

QUESTION 301. *How much force is required to make the driving-wheels of a locomotive slip on an ordinary railroad track?*

Answer. The force required to make them slip will, as already stated, vary very much with the condition of the rails. If they are quite dry and clean it will require a force equal to about one-fourth the weight on the wheels. That is, supposing we have a wheel, *A B*, fig. 192, attached to a frame which is fastened so that it cannot move, and that the wheel is loaded with say 10,000 pounds, if now a rope or chain could be attached at a point, *B*, exactly at the tread of the wheel, and carried over a pulley, *C*, then it would require a weight, *D*, of about 2,500 pounds attached to the end of the rope to make the wheel slip. If the rails were sanded, the adhesion would be somewhat greater, and if they were wet or muddy or greasy, considerably less. For ordinary circumstances the adhesion may safely be assumed to be *one-fifth of the weight of the driving-wheels.* Of course the total weight on all the driving-wheels must be taken in calculating the adhesion. Thus, if a locomotive has four driving-wheels and each one of them bears a load of 10,000 pounds, then the total weight on the driving-wheels, or *adhesive weight*, as it is called, will be $10,000 \times 4 = 40,000$ pounds, and the adhesion will be

$$\frac{40,000}{5} = 8,000 \text{ pounds.}$$

QUESTION 302. *What is meant by the tractive power of a locomotive?*

Answer. It is the force exerted by the piston on the wheels at their points of contact with the rails, which therefore tends to move the locomotive and draw the load attached to it. Thus in fig. 192 if the wheel *A B*, was made to revolve with a force which would just raise the weight *D*, the tractive power of that wheel would be 2,500 pounds, and if the engine had four such driving wheels its total tractive power would be $2,500 \times 4 = 10,000$ pounds.

The tractive power is of course due to the pressure of steam on the piston, and therefore its amount is dependent upon the average steam pressure in the cylinder, on the area of the piston, and also on the distance through which the pressure is exerted, or, in other words, on the stroke of the piston. Thus if we have a cylinder 16 inches in diameter and two feet stroke and an average steam pressure of 50 pounds per square inch, then as the area of such a piston would be 201 square inches, the average pressure on it would be $201 \times 50 = 10,050$ pounds, and as each piston moves through four feet during one revolution of the wheels, the number of foot-pounds of energy exerted by it would be $10,050 \times 4 = 40,200$, and for the two cylinders of a locomotive double that amount, or 80,400 foot-pounds. Now if the driving-wheels are five feet in diameter, their circumference would be 15.7 feet, and therefore the locomotive would move that distance on the rails during one revolution, if the wheels do not slip. The 80,400 foot-pounds of energy is therefore exerted through a distance of 15.7 feet, and therefore,

$$\frac{80,400}{15.7} = 5,121 \text{ pounds} =$$

the force exerted through each foot that the circumference of the wheel revolves and the locomotive moves. If the wheels were only half the diameter, or 2½ feet, then their circumference would be 7.85 feet and the tractive power would be

$$\frac{80,400}{7.85} = 10,242 \text{ pounds,}$$

or double what it was before. It will be seen, then, that the tractive force of a locomotive is dependent upon (1) the average steam pressure in the cylinders, (2) the area, (3) the stroke of the piston, and (4) the diameter of the driving wheels.

QUESTION 303. *How is the tractive power of a locomotive calculated?*

Answer. BY MULTIPLYING TOGETHER THE AREA OF THE PISTON IN SQUARE INCHES, THE AVERAGE STEAM PRESSURE IN POUNDS PER SQUARE INCH ON THE PISTON DURING THE WHOLE STROKE, AND FOUR TIMES THE LENGTH OF THE STROKE OF THE PISTON,* AND DIVIDING THE PRODUCT BY THE CIRCUMFERENCE OF THE WHEEL. The result will be the tractive power exerted in pounds. The adhesion must of course always exceed the tractive force, otherwise the wheels will slip.

QUESTION 304. *How is the locomotive made to advance by causing the wheels to revolve?*

Answer. The pressure of steam in the cylinders is exerted in one direction against the piston, and in the opposite direction against the cylinder head, as shown in fig. 192, in which the steam is represented by the dotted shading in the back end of the cylinder, and the direction of the pressure by the darts *s, s.* The pressure against the piston is communicated by the connecting-rod to the crank-pin *E*, and that on the cylinder-head is carried to the axle by the frame *F F*, and the direction of the two forces is indicated by the two darts, *a* and *b*. We may now regard the spokes of the wheels as acting as levers, and assume that the fulcrum is either at the center *G'* of the axle, or at *B*, the point of contact of the wheel with the rail.† We will assume that it is at the center *G'* of the axle, and for the sake of even figures that the wheel is six feet in diameter and cylinders have two feet stroke. We will also suppose that the engine is supported so that the wheels do not touch the rails, and that a chain or rope passing over a pulley *C* is attached to the wheels at *B* and with a weight at *D*. We now have a force, *a*, of 10,000 pounds exerted on the crank-pin *E'*, which would be balanced by

$$\frac{10,000 \times 1}{3} = 3,333 \text{ pounds.}$$

at *B*. In other words, it would require 3,333 pounds suspended from the chain at *D* to resist the strain at *E*. But when this is the case, the pressure at the fulcrum, or on the axle in the direction of the dart *c*, is $10,000 + 3,333 = 13,333$ pounds.

As the pressure against the axle in the opposite direction, *b*, is only 10,000 pounds, there will be an unbalanced force of 3,333 pounds acting in the direction of the dart *c*, and tending to move it that way. As the axle is attached to the locomotive frame, this force will of course have a tendency to move the whole machine, and is really the tractive force of the engine.

If, on the other hand, we regard the point of contact *B* of the wheel with the rail as a fulcrum, we have a force of 10,000 pounds acting against a lever, *EGB*, four feet long. There would therefore be a force, *c*, of

$$\frac{10,000 \times 4}{3} = 13,333 \text{ pounds}$$

exerted at *G'*, and as the pressure in the direction of the dart *b* is only 10,000, there would be an unbalanced strain of 13,333 —10,000=3,333 pounds acting against the axle in the direction of the dart *c*, or, in other words, there is 3,333 pounds more of force pulling the axle forward than there is pushing it backward.

When the crank-pin is below the axle, in the position shown in fig. 193, then if the center of the axle is regarded as the fulcrum we have a pressure of 10,000 pounds pushing against the front cylinder-head, which is transferred to the axle by the frames, and acts in the direction of the dart *c*, and we also have a pressure against the crank-pin *E* in the direction of the dart *a*. Now 10,000 pounds at *E* would exert a force of

$$\frac{10,000 \times 1}{3} = 3,333 \text{ pounds}$$

at *B* and

$$\frac{10,000 \times 2}{3} = 6,666 \text{ pounds}$$

at *G* in the direction of *b*. But the pressure on the cylinder-head pulls against the axle *G* in the direction *c* with a force of 10,000, so that the excess of strain in the direction *b* will be equal to 10,000—6,666=3,333 pounds. If we regard *B* as the fulcrum, the calculation is exactly the same, as 10,000 pounds at *E* exerts a force at *G* equal to

$$\frac{10,000 \times 2}{3} = 6,666 \text{ pounds,}$$

and the difference between it and the pressure exerted by the strain against the front cylinder-head is the force which urges the axle and with it the locomotive forward.

It will be seen, then, that it is immaterial which point is regarded as the fulcrum, as the result of the calculations is exactly the same.

It must not, however, be hastily supposed from what has been said that the total pressure against the axle can be greater than its resistance to the pressure. As soon as the one exceeds the other it will move. But supposing that it requires a force equal to 3,333 pounds to draw a train coupled to the engine, as soon as the difference between the force exerted against the axle by the piston to move it forward and that which presses it back exceeds 3,333 pounds, the locomotive will move the train. If it continues to exceed it the speed of the train will be accelerated and thus the resistance which holds the engine back and that which pushes it forward will always be equal.

QUESTION 305. *Does the fact that the piston is working from the end of a longer lever, E G' B, fig. 192, when the crank-pin is above the arch enable the locomotive to start a heavier train than when the crank-pin is below the axle and the piston is working against a shorter lever, G E B, fig. 193?*

Answer. No; because, as has already been shown, the pressure against the axle is the same in both cases. It is in fact only during the forward stroke that the pressure on the crank-pin moves the engine forward. The forward pressure which is exerted against the axle by the crank-pin is then greater than that exerted against it in the opposite direction by the cylinder-head and frames. It is this excess of crank-pressure which moves the engine and is the tractive force during the forward stroke. During the backward stroke the piston is pushing the axle backward, and the pressure against the front cylinder-head is pulling it forward. The latter then exceeds the former, and the difference between the two is the force which moves the engine forward. As has been shown, this difference is the same in both positions of the crank, and therefore the locomotive cannot from this cause pull more when the crank is above the axle than when it is below.

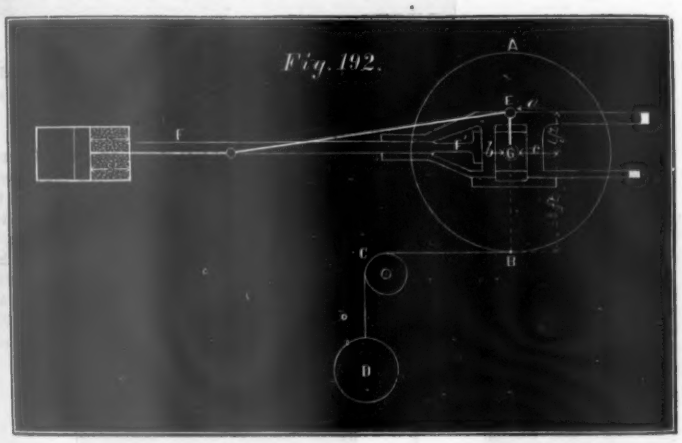


Fig. 192.

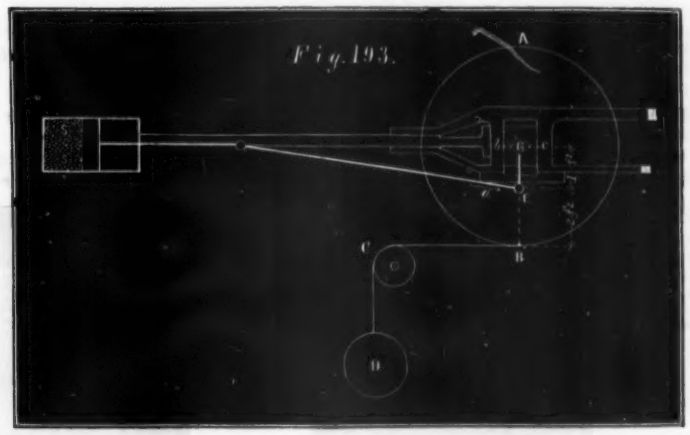


Fig. 193.

*This length may be taken in feet, inches or any other measure, but in making the calculation the circumference of the wheel must be taken in the *same* measure as the stroke of the piston.

†The question whether the center of the axle or the point of contact with the rail is the fulcrum of the lever in this case has been the subject of much animated discussion and contention. As the word *fulcrum* means "a point about which a lever moves," it is believed that the dispute is due simply to a difference in the meaning assigned to the word fulcrum. If we regard the fulcrum as the point which is fixed in relation to the locomotive, then it is at the center of the axle, but if we refer it to the surface of the earth, then it is at the top of the rail.

PART XIII.

INTERNAL DISTURBING FORCES IN THE LOCOMOTIVE.

QUESTION 306. *What are the internal disturbing forces in a locomotive?*

Answer. They are: 1, the momentum of the parts which have a reciprocating motion; 2, those due to the varying pressure of the steam in the cylinder-heads; 3, those caused by the thrust of the connecting rods against the guide bars; and, 4, those produced by unbalanced revolving parts.

QUESTION 307. *How can the effects of these disturbing forces be neutralized?*

Answer. By putting counterweights, *A, A*, fig. 161, in the driving wheels opposite the crank pins. The motion of these will then be in the reverse direction to that of the weight of the parts attached to the crank pins, and the motion of the one will thus to some extent, at least, neutralize the disturbing influence of the other.

QUESTION 308. *Can the weight of these counterweights be calculated for any locomotive?*

Answer. It can probably be calculated, but it is an exceedingly complicated problem, and one about which there is much difference of opinion. The difficulty is also increased by the fact that while counterweights may be heavy enough for one speed, they may be too heavy or too light for a slower or faster speed, and quite disproportioned when the engine is not working steam. The following rules are given in "Clark's Railway Machinery," and are perhaps sufficiently close to find a first approximation to the requisite position and weight of the counterweights; but the final adjustment should be made by trial. This can be done by suspending the locomotive by chains attached to the four corners of its frame, and setting the machinery in motion at the speed it is intended to run. By attaching a pencil to one or to each of the four corners of the frame, and arranging it so that it will mark on a horizontal fixed card, a diagram will be drawn, being usually an oval, which will show the amount and form of the oscillations. The

counterweights can then be adjusted so that the diagram drawn by the pencil is reduced to the least possible size. When the adjustment is successful, the diameter of the diagram is reduced to about 1-16 of an inch.‡ Another and simpler, but less accurate, way is to place a pail or other vessel filled with water on the front of the engine and running the loc motive on a smooth track at a high speed, and adjusting the counterweights so that the least amount of water will be spilled.

QUESTION 309. *How can the center of gravity of a counterweight in one segment be found?*

Answer. BY CUTTING A WOODEN TEMPLET OF UNIFORM THICKNESS TO THE FORM OF THE SURFACE, AND FREELY SUSPENDING IT BY ONE OF THE CORNERS, *a*, AS IN FIG. 194; A PLUMMET-LINE, *P a*, DROPPED FROM THE SAME POINT OF SUSPENSION IN FRONT OF THE TEMPLET WILL INTERSECT THE CENTER LINE *b c* AT THE CENTER OF GRAVITY *C*.

QUESTION 310. *How can the center of gravity of a counterweight in three segments be found?*

Answer. FIND THE CENTER OF GRAVITY *C'*, FIG. 195, OF ONE OF THE COUNTERWEIGHTS, AS ABOVE; THROUGH *C* STRIKE AN ARC FROM THE CENTER, *G*, OF THE WHEEL, AND CROSSING THE CENTER LINES OF THE OTHER SEGMENTS AT THEIR CENTERS, *C'*, *C''*; DRAW *C' C''* MEETING *A B* AT *D*, AND SET OFF *D E*, ONE-THIRD OF THE INTERVAL *D C*. THEN *E* IS THE COMMON CENTER OF GRAVITY OF THE THREE SEGMENTS.

QUESTION 311. *How can the center of gravity of a counterweight in two segments be found?*

Answer. This is required when the crank is opposite to a spoke, as in fig. 196. FIND THE CENTER OF GRAVITY, *C*, OF ONE SEGMENT AS BEFORE, AND BY AN ARC FIND THE OTHER CENTER *C'*; DRAW *C C'*, CUTTING *A B* AT *D*, THE COMMON CENTER OF GRAVITY.

QUESTION 312. *How can the center of gravity of a counterweight in four segments be found?*

Answer. FIND, AS BEFORE, THE CENTERS *C*, *C'*, *C''*, *C'''*, FIG. 197, OF THE SEGMENTS; DRAW *C'' C'* AND *C''' C*, CUTTING THE LINE *A B*; BISECT THE INTERVAL SO INCLOSED AT *E* FOR THE COMMON CENTER OF GRAVITY.

QUESTION 313. *How is the counterweight for outside-cylinder engines with a single pair of driving-wheels calculated?*

Answer. FIND THE TOTAL WEIGHT, IN POUNDS, OF THE REVOLVING AND RECIPROCATING MASSES FOR ONE SIDE, NAMELY, THE PISTON AND APPENDAGES, CONNECTING-ROD, CRANK-PIN AND CRANK-PIN BOSS; MULTIPLY BY THE LENGTH OF CRANK IN INCHES, AND DIVIDE BY THE DISTANCE IN INCHES OF THE CENTER OF GRAVITY OF THE SPACE TO BE OCCUPIED BY THE COUNTERWEIGHT. THE RESULT IS THE COUNTERWEIGHT IN POUNDS, TO BE PLACED EXACTLY OPPOSITE TO THE CRANK.

QUESTION 314. *How is the counterweight for outside-cylinder engines with coupled driving-wheels calculated?*

Answer. FIND THE SEPARATE REVOLVING WEIGHTS, IN POUNDS, OF CRANK-PIN, CRANK-PIN BOSS, COUPLING-RODS AND CONNECTING-ROD, FOR EACH WHEEL, ALSO THE RECIPROCATING WEIGHT OF THE PISTON AND APPENDAGES, AND HALF THE CONNECTING-ROD; DIVIDE THE RECIPROCATING WEIGHT EQUALLY BETWEEN THE COUPLED WHEELS, AND ADD THE PART, SO ALLOTTED, TO THE REVOLVING WEIGHT ON EACH WHEEL. THE SUMS SO OBTAINED ARE THE WEIGHTS TO BE BALANCED AT THE SEVERAL WHEELS, FOR WHICH THE NECESSARY COUNTERWEIGHT MAY BE FOUND BY THE PRECEDING RULE.

QUESTION 315. *How are the counterweights constructed?*

Answer. They are usually made of cast iron, so as to fill or partly fill the spaces between the spokes of the wheel, as shown at *A A* in fig. 161. Each of the segments consists of two pieces, one of which is put in from the outside of the wheel and the other from the inside. The two are then bolted together with bolts, which are shown in the above figure. In some cases the counterweights are cast solid with the wheels, and in others they are cast with the wheels but made hollow and the space inside is filled with lead, which is poured in when melted. Some locomotive builders make the rims and spokes of the wheels hollow and fill them with lead opposite to the crank-pins. It is difficult, however, to get the required weight in such wheels unless they are of large diameter.

‡ Rankine's Treatise on the Steam Engine.

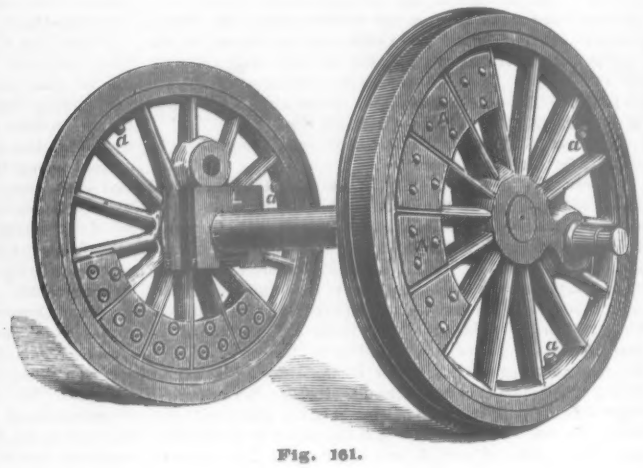
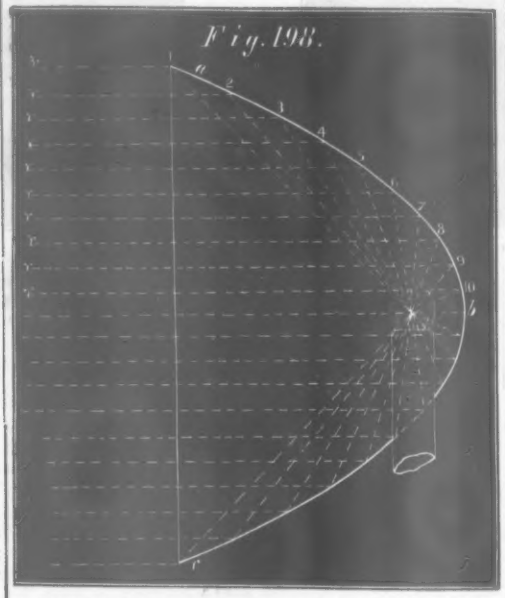


Fig. 161.

QUESTION 316. *What effect has the strain on the draw-bar, when the engine is pulling a load, upon the distribution of the weight in the wheels?*

Answer. It has the effect of pulling the back end of the engine down, and, as it is balanced on the fulcra of the equalizing levers, it at the same time lifts up the front end. In this way the harder a locomotive is pulling the greater will be the weight which is thrown on the driving-wheels, and that

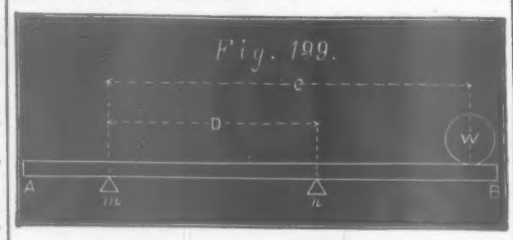


on the truck will be correspondingly diminished. The higher the draw-bar is above the rails the greater will be the tendency to pull the engine down behind and up in front.

PART XIV.

MISCELLANEOUS.

QUESTION 317. *What is the sand-box, V, V, figs. 40 and 41,§ for, and how is it constructed?*



Answer. It is intended to carry a supply of dry sand, which is scattered on the rails in front of the driving wheels when the latter are liable to slip. This is done by two pipes, *e'*, *e'*, fig. 40, one on each side of the engine. They lead from the sand-box to within a few inches of the rail. At the upper end and inside the sand-box they each have a valve which is operated by a lever which is connected to the cab by a rod which enables the locomotive runner to open or close the valve at pleasure.

The sand-box is usually made of sheet iron with an iron base and top of a more or less ornamental design. It also has an opening on top through which the sand is supplied to the box. This opening has a loose cover to exclude rain and dirt from the sand. The sand-box is usually located on top of the boiler in front of the front driving wheels.

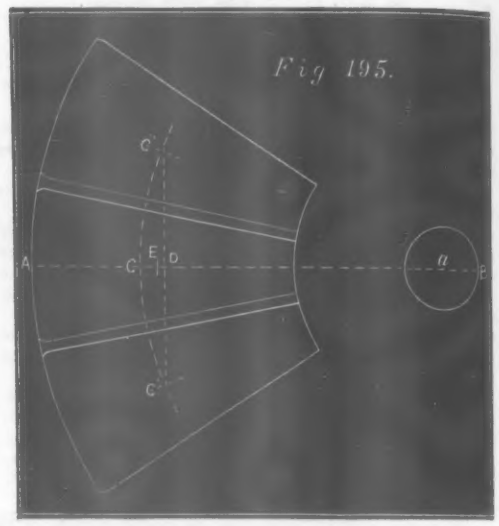
§ Published in the GAZETTE of June 27.

QUESTION 318. *What is the bell, U, U, for?*

Answer. It is used for giving signals of the starting or approach of the engine. It also is located on top of the boiler and is usually hung on a cast iron frame and rung with a rope connecting it with the cab.

QUESTION 319. *What is the weight of an ordinary locomotive bell?*

Answer. From 50 to 100 pounds.



QUESTION 320. *What is a locomotive head-light?*

Answer. It is a large lamp, *T*, *T*, figs. 40 and 41, placed in front of the locomotive to signal its approach at night and also to illuminate the track for the locomotive runner.

QUESTION 321. *How is a head-light constructed?*

Answer. The lamp has what is called an Argand burner; that is, a burner with a circular wick, through the center of which a current of air circulates, which thus supplies the flame with a larger quantity of air than is possible it the latter can come in contact with the former only from the outside. The result is that the combustion is much more brilliant than with ordinary burners. In order to throw all the light on the track the burner is placed inside of a concave reflector, *a b c*, fig. 198, which is of a *parabolic* form. One of the peculiarities of this form of reflector is that if a light is placed in its focus

f the rays will be reflected from its surface in parallel lines. Thus let *a b c*, fig. 198, represent a section of such a reflector. Now, if a light be placed in the focus *f* the rays will strike against the reflector, be thrown in the direction of the dotted lines *f* 1 *x*, *f* 2 *x*.... *f* 9 *x*, &c., and thus be thrown directly in front of the engine. The reflectors are usually made of copper and plated with silver.

The lamps and reflectors for head-lights are inclosed in a rectangular case which is supported on two brackets bolted to the front of the smoke box. On these brackets a wooden shelf is fastened on which the head-light rests.

QUESTION 322. *What are the running-boards and hand-rails?*

Answer. The *running-boards* are planks, *i i*, fig. 40, placed on each side of the boiler to enable the locomotive runner or fireman to go from the cab to the front end of the engine when it is running. The hand rails, *m' m' m'*, are brass or iron pipes attached to the top of the boiler and extending from the cab to the smoke-box and are placed there, as their name indicates to support or for a hand-hold for persons on the running board.

QUESTION 323. *What provision is made for removing obstacles such as cattle or fallen rocks, which are in front of locomotives, from the track?*

Answer. What is called a *cow-catcher* or *pilot*, *S*, figs. 40 and 41, is attached to the front of the locomotive. This is usually made of wood, and consists of a triangular frame at the bottom which is supported about four inches above the tops of the rails. Straight pieces of wood of about 2¼ × 4 inches section are fastened to this frame and also to a horizontal piece which is bolted to the bumper timber *E'*. These pieces arranged in this way and only a few inches apart give to the cow-catcher a peculiar curved form somewhat resembling that of the mould-board of a plow, which is very well adapted for throwing any obstacles from the track. Sometimes these pieces are placed horizontally instead of being inclined up and down. Cow-catchers are also in some cases made of round iron bars or angle iron. They are always bolted securely to the bumper timber and strengthened by strong iron braces attached to the bottom frame at the front and back. These braces are usually

fastened at the other end to the bumper timber, but are sometimes attached to the bed-plates of the cylinder.

There is also usually a strong *pushing-bar* attached with a bolt and hinged joint to the bumper-timber. This is shown in fig. 41 and 42 in the position it occupies when not in use. It is used in pushing cars, as very often there is not room for the pilot under the end of the car. In using it is raised up and the front end is then coupled to the draw-head of the car.

QUESTION 324. *What is the foot-board or foot-plate of a locomotive?*

Answer. It is a wrought or cast iron plate which extends across and rests upon the two frames at the back part of the locomotive and behind the boiler, and on which the locomotive runner and fireman stand. It also unites the two frames very securely, and furnishes an attachment for the draw-bar. The footboard is often made much heavier than is necessary for strength, in order to increase the weight, and thus the adhesion, on the driving wheels. It is a fact often not suspected that any weight placed on the back end of an ordinary locomotive will increase the load on the driving wheels by an amount considerably greater than that of the weight itself. The reason of this is that the locomotive rests on the center of the truck and the centers of the equalizers, and therefore the weight, if applied to the back end of the engine, gains considerable leverage. This will be clear if we take a beam, *A B*, and rest it on two supports, *m* and *n*, fig. 199. If now we put a weight *W* on the end, overhanging the point of support, the weight which will rest on *n* will be equal to that of *W* multiplied by its distance *C* from *m* and divided by the distance *D* between *m* and *n*. Thus if a footboard weighs 1,000 pounds, and its center of gravity is 5½ feet behind the center of the equalizer, and the latter 14 feet from the center of the truck, then the weight thrown on the driving wheels will be equal to $\frac{1{,}000 \times 19\frac{1}{2}}{14} = 1{,}393$ pounds. The same thing is of course true of any other weight placed on the back end of the engine.

QUESTION 325. *What are the "wheel-guards" of a locomotive?*

Answer. They are sheet-iron covers over the upper half of the periphery or tread of the wheels, and are placed there to protect the engine from the dirt and mud which adhere to the wheels and are then thrown off on the machinery by the centrifugal force.

QUESTION 326. *What are "check" or "safety chains?"*

Answer. There are two kinds of such chains, the one attached to the trucks and frames of the locomotive and the tender. The object of these chains is to protect the trucks from turning around and getting crosswise of the track if the trucks should leave the rails. The other kind of safety chains connects the engine to the tender, so that, in case the draw-bar or coupling pins should break, the two will not separate. Great care should be exercised to attach these chains so as to be strong enough to resist the strains to which they will be subjected in case the trucks run off the track. The grossest carelessness and ignorance are often shown in the construction of these parts.

ANNUAL REPORTS.

Chicago, Milwaukee & St. Paul.

The report of this company for the year 1873 (when its legal name was "Milwaukee & St. Paul, not having been changed till February last) gives the following information:

The company owns the following lines of road:

	Miles.
Chicago to Milwaukee	85
Milwaukee to St. Paul, via La Crosse	324
Milwaukee to St. Paul, via Prairie du Chien	345
Milwaukee to Portage City, via Horicon	96
North Milwaukee to Schwartzburg	6
Horicon to Berlin and Winneconne	57
Watertown to Madison	37
Milton to Monroe	42
Calmar to Algona, Iowa	126
Conover to Decorah, Iowa	10
Austin, Minn., to Mason City, Iowa	40
Mendota to Minneapolis, Minn	9
Hastings to Glencoe, Minn	75
Sabula to Marion, Iowa	87
Total miles owned by the company	1,399

With these lines were 182 miles of sidings and second tracks. There was an increase in length of 110 miles, or 8⅔ per cent., during the year. The average mileage worked during the year was 1,384.

The company at the close of the year owned the following equipment:

Locomotives	198 or 1 to	7.07 miles
First-class coaches	64 or 1 to	21.85 "
Second-class coaches	32 or 1 to	43.70 "
Sleeping cars	11 or 1 to	127.20 "
Baggage, mail and express cars	57 or 1 to	24.54 "
Box, freight and caboose cars	2,984 or 1 to	0.48 "
Flat and coal cars	671 or 1 to	2.09 "
Boarding cars	2 or 1 to	700.00 "

Besides this property the company owns $2,001,000 (a majority) of the Western Union Railroad Company's shares, which have cost it $1,500,750, and bonds of sundry railroads and cities which are inventoried at $183,771.

This property is represented by:

Capital stock.		
Preferred ($8,774 per mile)	$12,274,483	
Common ($11,007 per mile)	15,399,261	
		$27,673,744
Funded debt.		
First mortgage 7s	$18,422,000	
First mortgage 8s	4,455,500	
Second mortgage 7s	1,191,000	
Second mortgage 7.3s	1,315,000	
Sundry 7s	633,000	
Equipment bridge 10s	245,000	
Incumbrances assumed	20,110	
		26,281,610
(Funded debt per mile $18,786)		
Total ($38,567 per mile)		$53,855,355

The interest charge on the funded debt during the year was $1,539,643, some of the bonds having been issued during the year, and not bearing interest during the whole of it. The annual interest as indicated by the whole table will be $57,300 more, or at the rate of $1,353 per mile. Subtracting the cost of the Western Union Railroad from the amount of stock and bonds, the remainder is at the rate of $37,480 per mile of road owned by the company.

The work of the year consists of the following:

	No. Miles.	Earnings per Mile.	Expenses per Mile.
Passenger train mileage	1,352,256	$1.37	$1.39
Freight train mileage	3,376,299	1.90	
Service train mileage	477,333		
Passengers carried one mile			52,252,558
Tons of freight carried one mile			257,638,532

The receipts and expenses for two years were:

	1872.	1873.	Increase.
Freight	$4,566,991.24	$6,421,369.24	$1,854,378.00
Passengers	1,775,714.84	1,857,196.43	81,481.59
Miscellaneous	615,065.10	767,557.90	152,492.80
Total	$6,957,771.18	$9,046,123.57	$2,088,352.39
Working expenses	4,695,615 97	6,594,560.33	1,898,944.37
Net earnings	$2,262,155.21	$2,451,563.24	$189,408.03

This shows an increase of 30 per cent. in gross earnings, 40.4 per cent. in working expenses, and 8.4 per cent. in net earnings. The working expenses were 73 per cent. of the receipts, against 67¼ per cent. in 1872. The expenditures include $1,600,052 called "extraordinary," in 1873, against $584,339 for the same items the previous year; $1,408,460 of this was for renewals of track, amounting to 68 miles of steel rails and about 63 of new iron. This, however, is less than 10 per cent. of the mileage of the company, and probably would not be more than the average annual renewal (of iron) necessary, if so large a proportion of the company's lines were not new. More than 500 miles of its lines, however, have been completed but a short time, and have not had traffic enough yet to make any considerable renewals of rails necessary.

There were also expenditures for new construction, not charged to working expenses, amounting to $1,330,803.63, $522,000 of which was for additions to rolling stock.

In the following summary of results by divisions, which forms one of the most interesting and valuable parts of the report, the Chicago & Milwaukee Division includes only the line between the places named, the La Crosse Division the 196 miles from Milwaukee to La Crosse and the 37 from Watertown to Madison, the River Division the 128 miles from La Crescent to St. Paul, the Prairie du Chien Division the 193 miles from Milwaukee to Prairie du Chien with the 42 miles from Milton to Monroe, Wis., the Iowa & Minnesota Division the 212 miles from Mc Gregor, Iowa, (opposite Prairie du Chien) to St. Paul, with its branch of 10 miles from Conover northeast to Decorah, Iowa; the branch from Austin, Minn., southwest 40 miles to Mason City, Iowa, and the branch from Mendota, Minn., north 9 miles to Minneapolis—in all 271 miles, while the Iowa & Dakota Division is the line extending from the last named division at Calmar, Iowa, west 126 miles to Algona, the results in the table being given for the two divisions last named, which have together 397 miles; the Northern Division includes the 96 miles from Milwaukee by way of Horicon to Portage City, the 57 miles of the forked branch of this line from Berlin northward to Berlin and Winneconne, and the 6 miles from Milwaukee to Schwartzburg—159 miles in all; the Hastings Division is the late Hastings & Dakota Railroad, from the Mississippi at Hastings, Minn., westward 75 miles to Glencoe; and the Illinois & Iowa Division, which is connected with the Milwaukee & St. Paul only through the Western Union Railroad, is the late Sabula, Ackley & Dakota Railroad, extending from the Mississippi at Sabula, Iowa, westward 87 miles to Marion.

DIVISIONS.

	Chicago & Milwaukee.	La Crosse.	River.	Prairie du Chien.	Iowa & Minn. and Iowa & Dakota.	Northern.	Hastings & Dakota.	Illinois & Iowa.	All Divisions.
Miles run by passenger trains	139,145	262,933	167,260	280,089	260,038	142,324	40,922	39,335	1,132,256
Miles run by freight trains	235,432	1,090,462	212,617	880,733	648,800	269,956	39,031	69,179	3,376,299
*Miles run by wood and gravel trains	73,100	138,670	55,025	76,400	80,755	36,613	13,070	19,700	477,333
Total miles run	447,677	1,441,985	434,902	1,237,121	989,593	448,903	93,013	128,204	4,985,888
Tons freight carried one mile	20,339,408	78,303,545	18,977,495	75,744,849	57,738,937	22,189,725	1,231,810	1,977,613	297,618,532
Passengers carried one mile	8,304,853	16,003,982	7,014,868	8,264,383	7,673,987	4,471,666	339,696	274,691	52,252,558
Earnings per mile run on freight	$1.79	$1.87	$2.01	$2.13	$1.61	$2.26	$1.43	$0.92	$1.90
Earnings per mile run on passengers	1.80	1.91	1.53	1.06	1.26	1.06	0.40	0.26	1.37
Expenses per mile run, including all expenditures	$1.15	$1.73	$1.13	$1.26	$1.42	$1.33	$1.11	$0.84	$1.39
Percentage of expenses to earnings, including all expenditures	86 per ct.	93 per ct.	89 per ct.	69 per ct.	87 per cent.	66 per ct.	117 per ct.	115 per ct.	73 per ct.
Amount received per ton per mile	.02 7-100	.02 25-100	.02 24-100	.02 47-100	.02 87-100	.02 80-100	.02 36-100	.02 32-100	.02 50-100
Amount received per passenger per mile	.03 5-100	.03 49-100	.03 64-100	.03 60-100	.04 34-100	.03 93-100	.04 97-100	.04 4-100	.03 88 100
Length of road December 31, 1873	85 miles.	283 miles.	128 miles.	235 miles.	397 miles.	169 miles.	75 miles.	87 miles.	1,399 miles.
†Gross earnings per mile of road	$10,323 83	$11,631 62	$5,992 85	$10,080 87	$3,728 85	$5,838 85	$980 18	$911 31	$6,536 22
Net earnings per mile of road	4,583 06	1,936 81	2,519 87	3,807 07	478 85	1,807 86	.....	.....	1,771 36

* Work and gravel trains are not included in above percentages.

† In calculating the gross and net earnings per mile of road, the average number miles on new lines in proportion to date of completion were used.

The receipts per ton and per passenger per mile on the different divisions were:

Division.	Per passenger.	Per ton.
Chicago & Milwaukee	3.05 cts.	2.07 cts.
La Crosse	3.42 "	2.55 "
River	3.64 "	2 24 "
Northern	3.52 "	2.80 "
Oshkosh & Mississippi Railway	3.57 "	2.88 "
Madison & Portage Railroad	4.13 "	2.54 "
Prairie du Chien	3.60 "	2 47 "
Iowa & Minnesota	4.34 "	2.68 "
Iowa & Dakota	4.33 "	2.08 "
Hastings & Dakota	4.87 "	3.36 "
Illinois & Iowa	4.04 "	3.27 "
Total eastward	3.67 "	2.31 "
Total westward	3.51 "	3 26 "
Average of all the traffic in both directions	3.58 "	2.50 "

The net earnings during the year were one-third more than the interest on the funded debt, and the surplus, if not otherwise expended, would have paid about 5 per cent. on the preferred stock, or 2¼ per cent. on the entire capital stock.

Western Union Railroad.

This company, which is controlled by the Chicago, Milwaukee & St. Paul through the ownership of a majority of its stock, consists of a line from Racine, Wis., southwestward 192 miles to a junction with the Chicago, Rock Island & Pacific Railroad near Rock Island, a branch from Elkhorn, 41 miles west of Racine, northward 16½ miles to Eagle, connecting with the Prairie du Chien line of the Chicago, Milwaukee & St. Paul, and a branch 4¼ miles long from Watertown, Ill., to Hampton Coal Mines—a total of 212¾ miles. Ten miles at the southwestern end, from Port Byron, Ill., to Rock Island Junction, was bought from the Chicago, Rock Island & Pacific Company in 1873, having been worked on a lease previously, and the branch to Hampton Coal Mines was built during that year, so the mileage owned is 14¼ miles greater than in 1872 and the mileage worked 4¼ miles greater. Its rolling stock at the close of the year consisted of: 30 locomotives, 11 first-class coaches, 1 sleeping car, 1 business car, 3 baggage, mail and express, 9 baggage and second-class combined, 372 box freight and caboose, 64 stock, 33 flat and 48 coal cars, 1 derrick and 1 pile-driver car.

This property is represented by

Stock ($18,801 per mile)	$4,000,000
First-mortgage bonds ($16,451 per mile)	3,500,000
Total ($35,252 per mile)	$7,500,000

During the year 1873 the work done by this road was:

Passenger-train mileage	174,784
Freight-train mileage	5 8 716
Service-train mileage	48,215
Total	751,715
Tons carried one mile	41,289,377
Passengers carried one mile	5,126,767

The earnings and expenses were for two years:

	1872.	1873.
From freight	603,098 97	$695,308 86
From passengers	208,056 56	200,533 72
From mails, express, etc	35,955 68	41 791 65
Total earnings	$847,111 21	$1,137,634 23
Working expenses	702,960 18	878,241 37
Net earnings	$144,151 03	$259,392 86

There is an increase of 35⅓ per cent. in gross earnings, 25 per cent. in working expenses and 80 per cent. in net earnings. The latter exceeded the interest on funded debt by about $62,000, which is about 1¼ per cent. on the stock. The earnings per mile were $5,347 in 1873 and $4,063 in 1872, the increase being 31⅓ per cent. The receipts per ton per mile were 2.08 cents on eastward and 2.42 on westward freight, the average being 2.17 cents. The receipts per passenger mile were 3.89 cents eastward, 3.94 westward and 3.91 on the average. The earnings per train-mile were $1.69 for freight and $1.28 for passengers, the average expense for all being $1.25. The proportion of expenses to earnings was 77 per cent.

PERSONAL.

—Governor Tod R. Caldwell, of North Carolina, who died recently, was for several years, from 1865 to 1868, we believe, President of the North Carolina Railroad Company.

—Col H. D. Whitcomb, late Chief Engineer of the Chesapeake & Ohio Railroad, and who was recently appointed by the President of the United States one of the Commissioners on the improvement of the mouth of the Mississippi, has also been chosen Chief Engineer of the James River Improvement.

—Mr. C. G. Mac has resigned his position as Superintendent of the Paris & Decatur Railroad, and has secured an interest in an iron foundry at Mattoon, Ill., to which business he will devote his time hereafter.

—Mr. W. A. Waterbury has resigned his position as Superintendent of the New Haven, Middletown & Willimantic Railroad, and will engage in manufacturing in Bridgeport, Conn.

—It is said that Mr. Henry C. Robinson, of Hartford, declines to take Mr. Bishop's place as President of the New York, New Haven & Hartford Railroad Company. It has been stated that Mr. Bishop intended to resign his position on account of his advancing age. It is true that he is not a young man, but his recent argument before the Connecticut Legislative Committee in the Parallel Railroad case, and his general conduct of that case, show that he has a store of energy and acuteness left which many younger men might be thankful for.

—Mr. R. G. Hervey, of Terre Haute, Ind., President of the Paris & Decatur Railroad Company, had his collar bone broken by a collision on the Erie Railway near Canaseraga, N. Y., July 18, the car in which he was being completely wrecked. Mr. Nathaniel Van Horn, of Philadelphia, Southeastern Agent of the Erie, had a leg and an arm broken at the same time and is reported to be in a critical condition.

—Mr. Elijah L. Watson, Assistant Superintendent of the Concord Railroad, died suddenly of paralysis, July 17.

THE SCRAP HEAP.

Railroad Manufactures.

The Rome (N. Y.) Iron Works are now running night and day with a force of 150 men. The works comprise a rail-mill, 200 by 120 feet, with two trains of rolls and an engine of 400 horse power; a puddling mill 200 by 75 feet with a 350-horse engine; and a machine shop with a 50-horse engine. The capacity of the rail mill is 20,000 tons of new rails annually.

A contract has just been awarded the Baltimore Bridge Company to build two iron bridges for the Lima & Huacho Railroad, in Peru, each to be of two spans and each span 60 feet long.

The Milwaukee (Wis.) *Sentinel* says: "The Devere Car-works have just received an order for the construction of 50 box cars for the St. Paul Railway, and an order for cars from the North Wisconsin Railroad."

The Jackson & Sharp Company at Wilmington, Del., has been building some passenger cars for the Lehigh Valley Railroad.

The Pittsburgh & McKeesport Locomotive Works are building a 16-ton locomotive for Messrs. Joseph Keeling & Co., coal merchants of South Side; also a 22-ton locomotive for the Buffalo Valley Railroad. This company has long built cars, but has only recently commenced the construction of locomotives.

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S. WRIGHT DUNNING AND M. N. FORNEY.

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Editorial Announcements.

Addresses.—*Business letters should be addressed and drafts made payable to* THE RAILROAD GAZETTE. *Communications for the attention of the Editors should be addressed* EDITOR RAILROAD GAZETTE.

Contributions.—*Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies, the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and in their management, particulars as to the business of railroads, and suggestions as to its improvement. Discussions of subjects pertaining to* ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

Advertisements.—*We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay,* EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and those only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially, either for money or in consideration of advertising patronage.*

LOCOMOTIVE REPORTS AND PERFORMANCE.

During the past twenty years the consumption of fuel by sea-going steamships has been reduced fully one-half. That is, the best class of marine engines of the present day consume less than half as much coal as the most improved and best-constructed engines did twenty years ago. The practical effect of this reduced consumption of fuel is that many lines can now be run profitably which would, without the improved engines, entail a loss to the owners. This result has been achieved, not by the intuitions of untutored firemen, nor evolved out of the inner consciousnesses of mechanics, who assume superiority because they don't know what others have learned by hard study, nor has it been achieved by any ingenious trick or cunning contrivance, but it has been the result of patient, careful and intelligent study by the ablest engineers in the world men who were neither above nor below using every available means, whether it was the infinitessimal calculus to investigate the science of steam, a draftsman's pencil and T square to represent their ideas, or handling a fireman's shovel and giving instruction in the art of using coal economically. Besides these and other means which they made use of, they collected with the utmost care the records of the performance of all kinds of engines that came under their observation, and made the most careful comparisons of their performance. Such engines were, and are still frequently, built under contracts to perform certain work with a specified consumption of fuel, and before being accepted by the purchasers and during their period of probation are managed by the engineers who built them, or their representatives. Of course every possible means is then employed to produce economical working. The best trained firemen are employed, every part of the engine is carefully protected from radiation and loss of heat, the boilers are kept clean, and every refinement that science and experience can suggest is employed to reduce the consumption of fuel.

The result and the means of achieving it have, we think, not received the attention which they deserve from railroad managers. On the contrary, the utmost indifference is manifested by the great majority of them regarding the whole subject. So great is this indifference that on perhaps a majority of roads no account whatever is kept of the fuel consumed, and usually there is an absolute ignorance of the performance of both the engines and the men that run them. That this condition of things should exist, seems almost incredible, considering the enormous pecuniary interests which are involved. To show how great these interests are, we quote from the last report of the Lake Shore & Michigan Southern Railway. The cost of operating the locomotives and the percentage which each item bears to the whole cost of operating the road is given as follows:

	Cost.	Percentage of total cost of operating.
Enginemen and firemen	$900,217 79	6.77
Repairs of engines and tenders	774,487 35	5.82
Fuel consumed	1,521,393 83	11.46
Oil and tallow	169,140 31	1.27
Waste and rags	52,385 71	.39
Total	$3,417,624 99	25.71

This road is managed, we believe, as economically as other lines, and as is perhaps possible without adopting some unusual means of reducing expenses. As stated before, considering the enormous expenditure it seems at first sight extraordinary that such means are not employed by every railroad company in the country. A little acquaintance with the conditions under which the affairs of railroad companies are conducted will lessen the surprise; and though it may not incline us to believe that "whatever is, is right," will convince us that there are adequate reasons for "whatever is." In the case of railroad companies, the reason for the indifference is, we believe, often the want of sufficient capital. The effect of this is apparent in ordinary business. Nearly all merchants can get a reduction of 10 per cent. per annum or more on all their purchases by paying cash, and the only or chief reason they don't do it is that they have not the cash. So with railroad companies. An expenditure of thousands or millions this year might double or treble itself in a few years, but if the thousands or millions are not available the company must do the best it can without. An immediate expenditure might result in a large economy at the end of the year, but if the treasury is empty and bills payable falling due each month, they must be met even at the expense of unprofitable working.

Another reason is, that the managers—that is, the boards of directors and executive officers, or those who control them—are often not interested in the economical management of the property entrusted to them. They find it more profitable to manipulate the stock or bonds for their own private purposes and profit, than to trouble about such affairs as locomotive expenses or economical management. Officers are then appointed without any reference to capacity or skill, but more because they may be depended upon to keep silent when to speak aloud would interfere with some person's little game.

Then, too, it often, and we may say usually, happens that all the officers, from the president down, have more to do than they can possibly look after, so that their time and energies are exhausted in simply keeping things going, although they may not go to the best advantage. Reformers on railroads as well as elsewhere have to contend with prejudice, selfishness and, what is perhaps more discouraging, that mental inertia and skepticism which so often, and it may perhaps be truthfully said, so certainly result from a life devoted exclusively to money-getting and money-keeping. It is very singular how incapable such men often become of seeing the relations of means to ends, and railroad superintendents or master mechanics, in proposing to boards of directors to sell old and wasteful engines for scrap iron, often find themselves addressing incredulous hearers who from confirmed habit are incapable of relaxing their grasp on what is in their possession, or of seeing that thereby they will be profited in the end.

In remedying all evils, the first step is usually to determine accurately its extent and nature, and it is of this especially that we want to speak here. Of the importance of keeping accurate fuel accounts on all railroads we have frequently spoken, and although the present locomotive reports have no value for purposes of comparison of one road with another, yet on the same line they enable the master mechanic to tell which of his engines and men are doing the best service, and to know when any of them are working wastefully. It is, however, we believe, of the utmost importance that some system of keeping locomotive reports should be adopted which will show accurately not only the cost, but the absolute amount of work done on each line. At present in taking up any two reports it is impossible to tell how much work has been done by the locomotives on each line. The one may have a level road, and therefore be able to haul 40 cars, and the other have one grade which will make it possible for him to haul only 20. The one may be straight and the other crooked; one may have many short grades and the other long ones; on one the grades and curves may be simultaneous, and on the other *vice versa*. The time on one road may be fast and on the other slow, the fuel and water on one line good and on the other very bad, so that those who have given most attention to this subject are apt to be the most decided in thinking that any system of locomotive reports which will be quite accurate and represent the actual amount of work performed by locomotives on different roads is impossible. Now, notwithstanding the impression of the supposed insoluble nature of the problem, we are inclined to believe that its solution is simpler than at first sight appears when the complicated elements of which it is composed are regarded separately. Although it is perhaps impossible to fully develop a system of preparing such accounts without some carefully conducted experiments and study of the practical circumstances with which it is surrounded, yet we will venture to suggest a method by which a system might be developed for keeping the fuel reports of locomotives which would for all practical purposes be perfectly accurate, and which would enable each railroad company to compare its reports with those of all the rest. The system is simply to reduce all locomotive service to foot-pounds of work done, a problem which at first sight does not appear easy, but it is, we believe, less difficult than it appears. A foot-pound, as most of our readers doubtless know, is the power required to raise one pound one foot high. Now supposing the resistance of a car on a level and straight track to be eight pounds per ton (of 2,000 pounds) at ten miles an hour, and the car weighs 20 tons, then the number of foot-pounds of work performed in pulling that car one mile would be equal to the number of feet in a mile multiplied by the weight of the car in tons and the resistance in pounds per ton, or $5,280 \times 20 \times 8 = 844,800$ foot-pounds. If there was an ascending grade of 20 feet per mile, then the resistance would be about 16½ pounds per ton, and the work done would be equal to $5,280 \times 20 \times 16\frac{1}{2} = 1,742,400$ foot-pounds. If the car ran 100 miles with an average resistance as above, then the work done would of course be 100 times the above, and with an average resistance of 16½ tons with a train of 40 cars in running 100 miles there would be 6,969,600,000 foot-pounds of work performed. Such figures would of course become unwieldy, showing that our unit of measurement—a foot-pound—is too small. We therefore propose the adoption of the "mile-pound" instead, by which we mean the amount of power consumed in raising one pound a mile high or 5,280 pounds one foot high. In running 100 miles then there would be, with our train of 40 cars, 1,320,000 mile-pounds of work performed. But in hauling such a train it is necessary to haul the weight of the engine and tender, which will require as much power as an equal amount of weight of cars. Taking the weight of engine and tender at 50 tons, there would be 82,500 mile-pounds of work performed in hauling them over the 100 miles of our hypothetical road, so that in hauling the train referred to there would be 1,402,500 mile-pounds of work performed in travelling 100 miles. It may be that the mile-pound is too small a unit of measurement, and that the "mile-ton" should be the standard. If that were used, the work done in hauling our train would be expressed by 701¼ mile-tons.

The question then of course naturally comes up, How can we determine the amount of power consumed in hauling a train over any given road? This could, we think, be done experimentally with a properly constructed dynamometer car. If, for example, we had a car which would draw a continuous diagram of the resistance of a train of a known weight, while running over the whole length of any road, we could from that easily determine the average resistance. This once determined could always be used thereafter as a co-efficient in calculating the work done on such a line. Thus, suppose it was found that the average resistance per ton for hauling a train from New York to Albany over the Hudson River Railroad was 10 pounds per ton at the time-card speed, and that over the Harlem Railroad, which has heavier grades and sharper curves, it was 13 pounds, then evidently there would be 3-10 or 30 per cent. more work done in hauling a train over the Harlem than there would be over the Hudson River Railroad. It would, in fact, only be necessary to determine the average resistance on different roads, and keep an account of the cars hauled in each train, to determine accurately the amount of work done by locomotives on each line. There would, of course, be some difference, owing to the weather and force of the wind, but these during any considerable period, such as a month or a year, would average nearly alike. The condition of the track might also influence the resistance of the trains, but if any material change occurred the average resistance might be tested as often as such change occurred.

There might be some difficulty in determining the weight of cars, as it would manifestly be impossible to weigh each train. A sufficiently near approximation might, we think, be reached by weighing say 100 or more ordinary loaded cars, and from that taking an average for a standard to be used in estimating the work done by locomotives. The average weight of the cars hauled in a month or a year would not vary much from this, we believe. Of course absolute accuracy would be impossible, as it is in all railroad accounts, but the plan proposed would give a common standard of comparison which would enable us to know the relative economy with which the locomotives on each road and the different divisions of a road are operated. Thus, supposing that it was found that the locomotives on the Central Railroad of New Jersey were doing 1,000,000 mile-pounds of work with three tons of anthracite coal, and that the Hudson River Railroad was doing the same work with two tons of Cumberland

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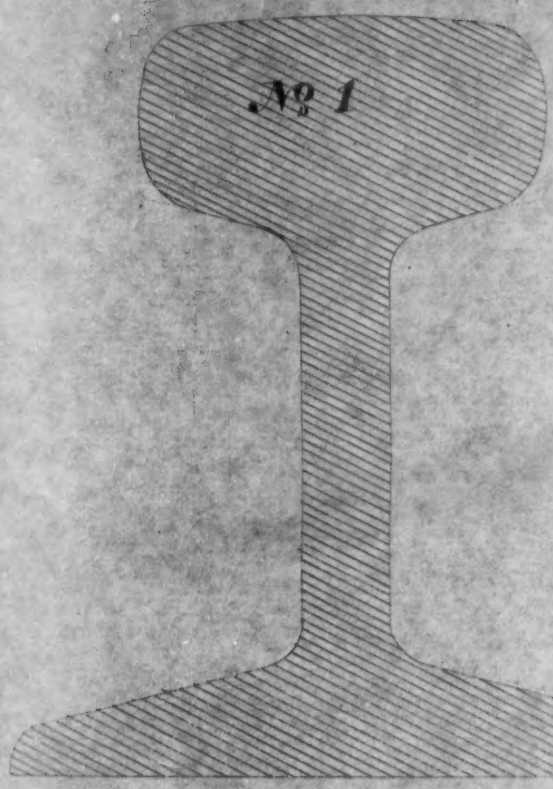
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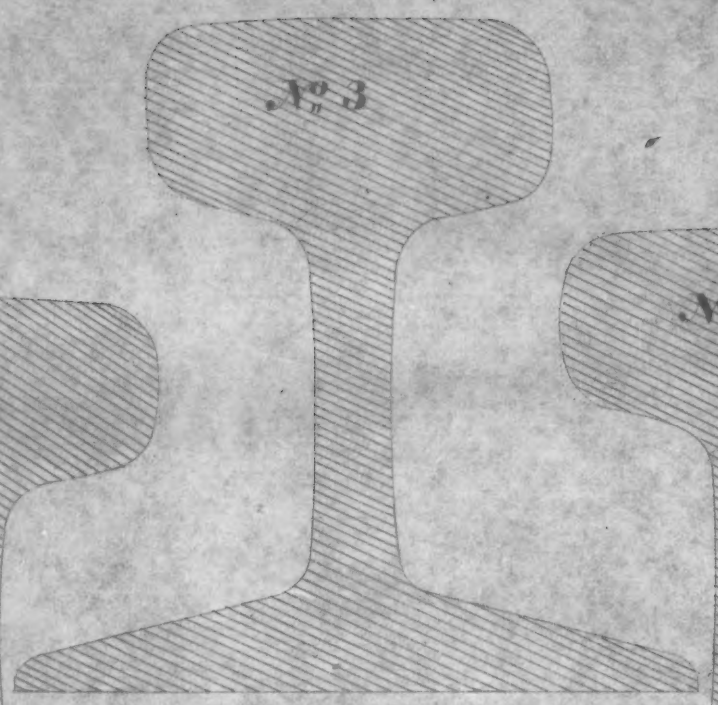
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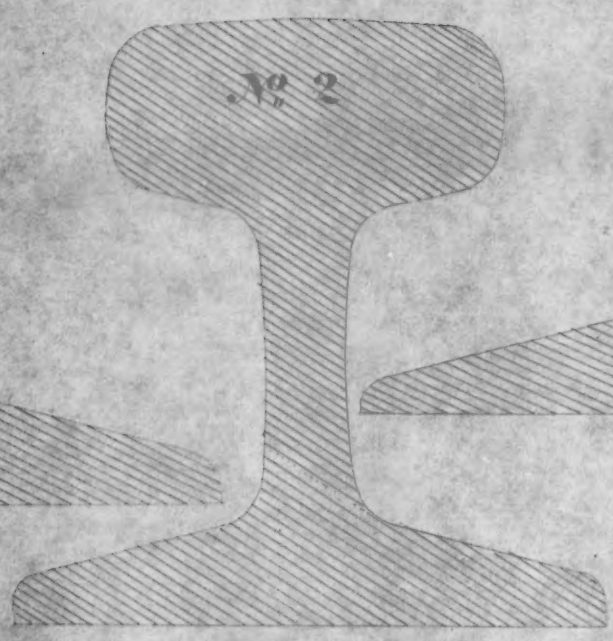
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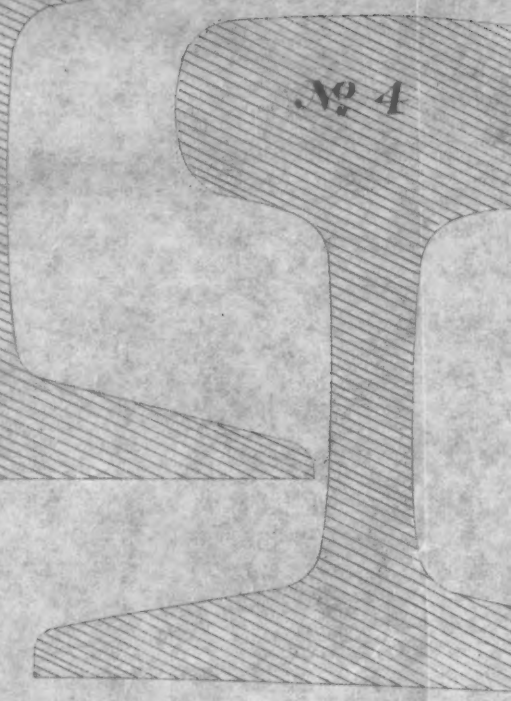
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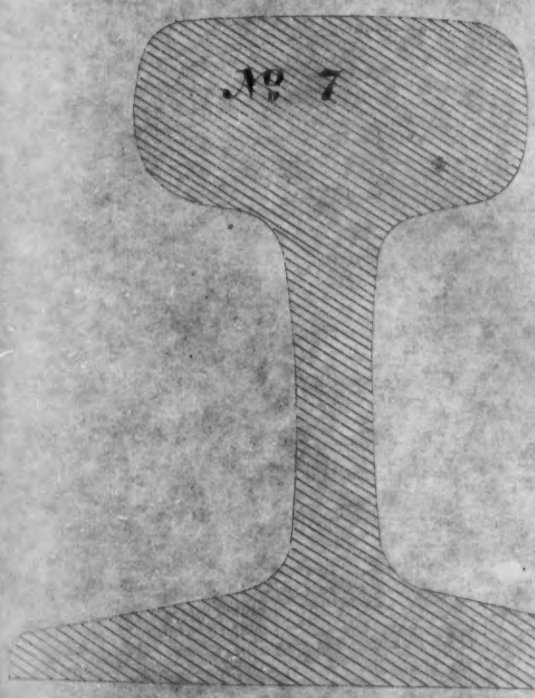
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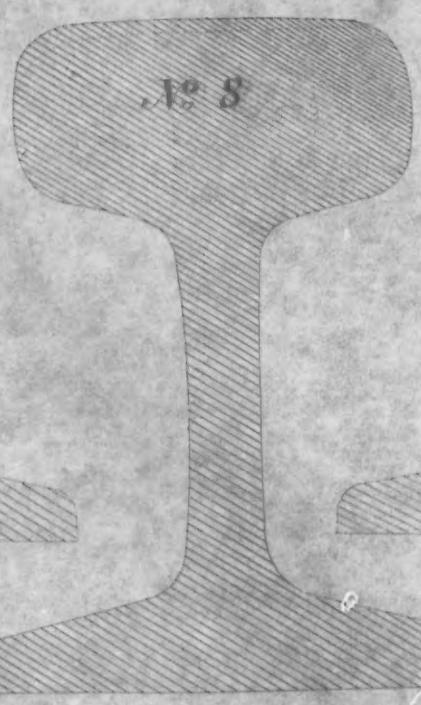
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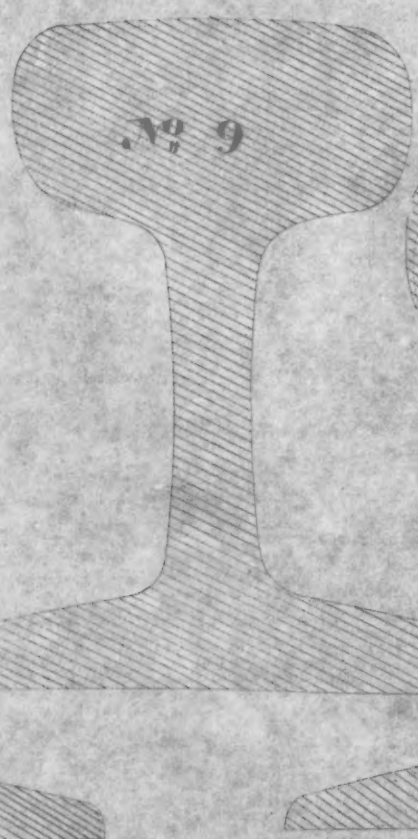
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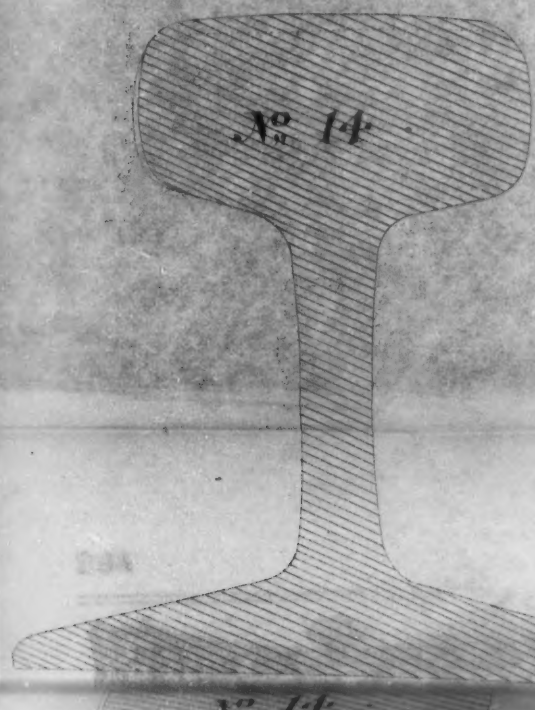
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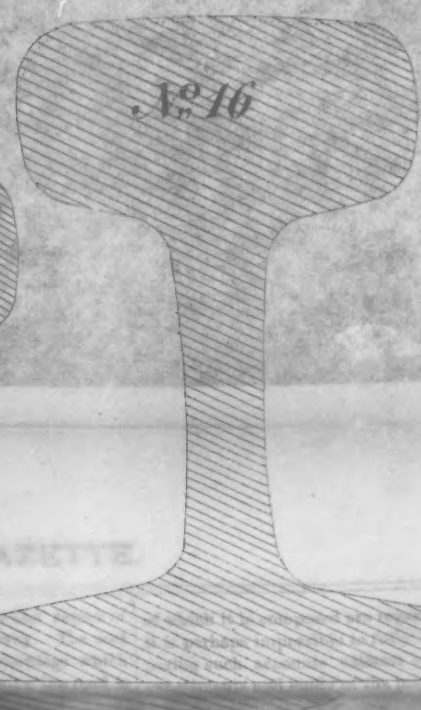
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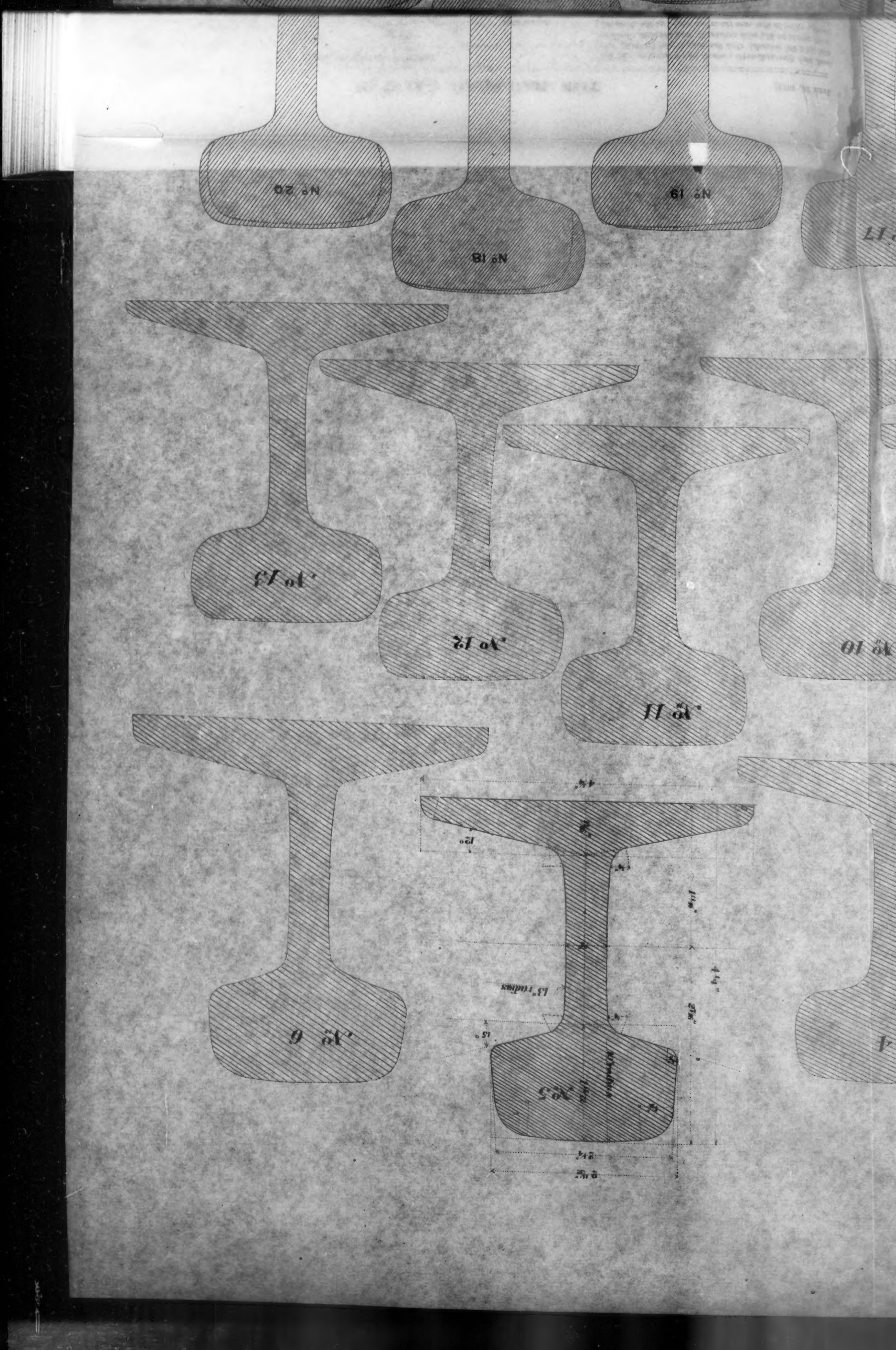
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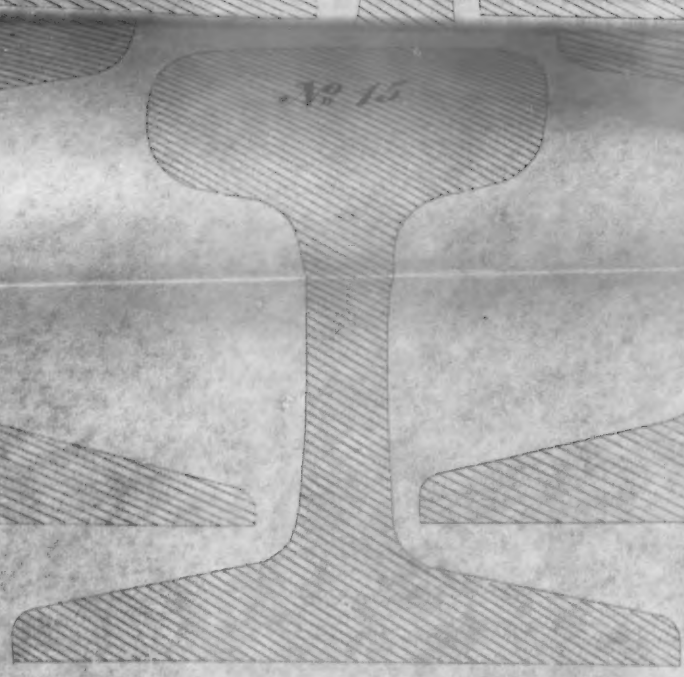
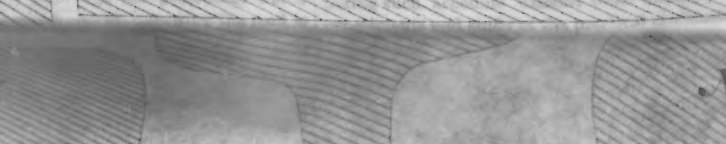
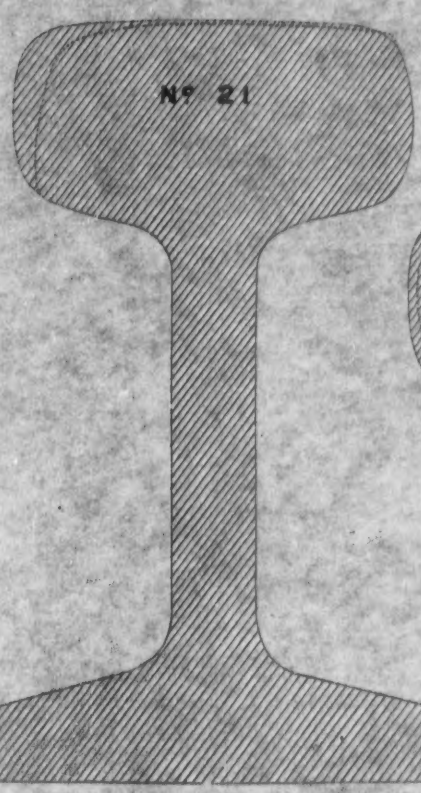
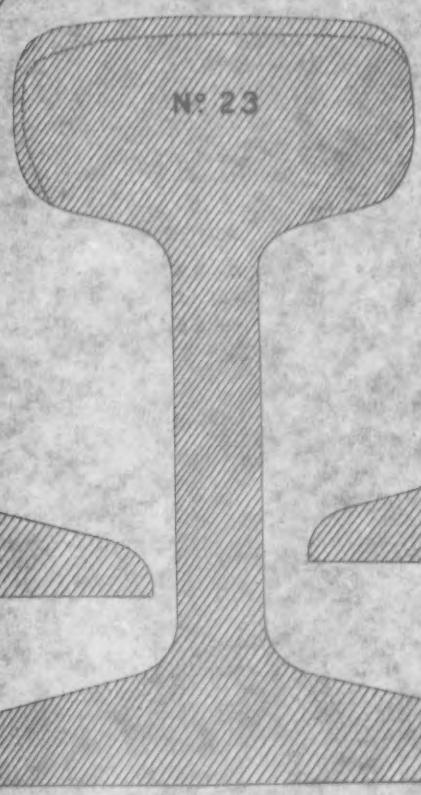
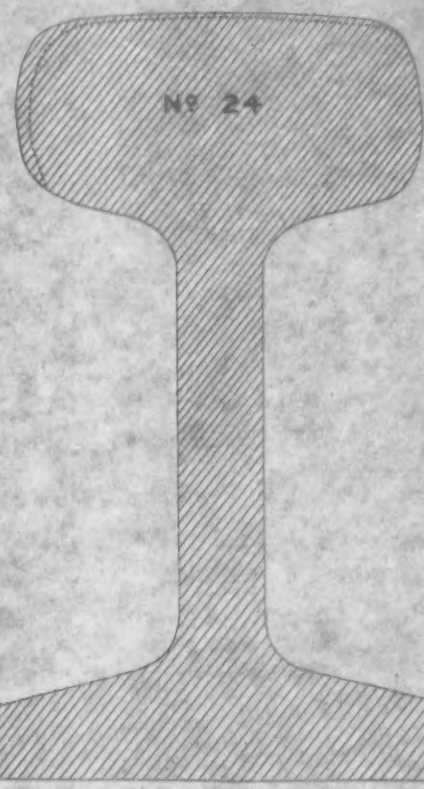
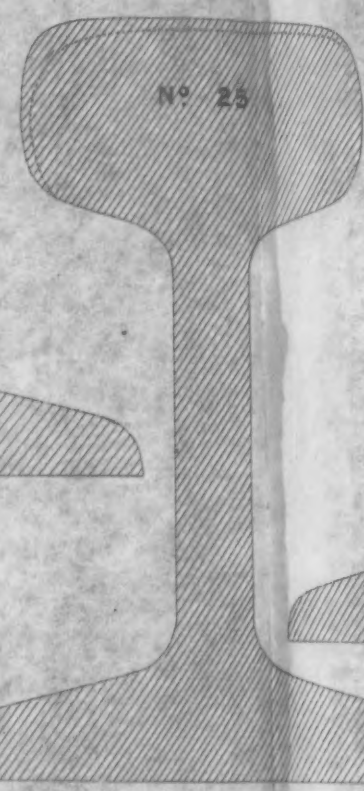


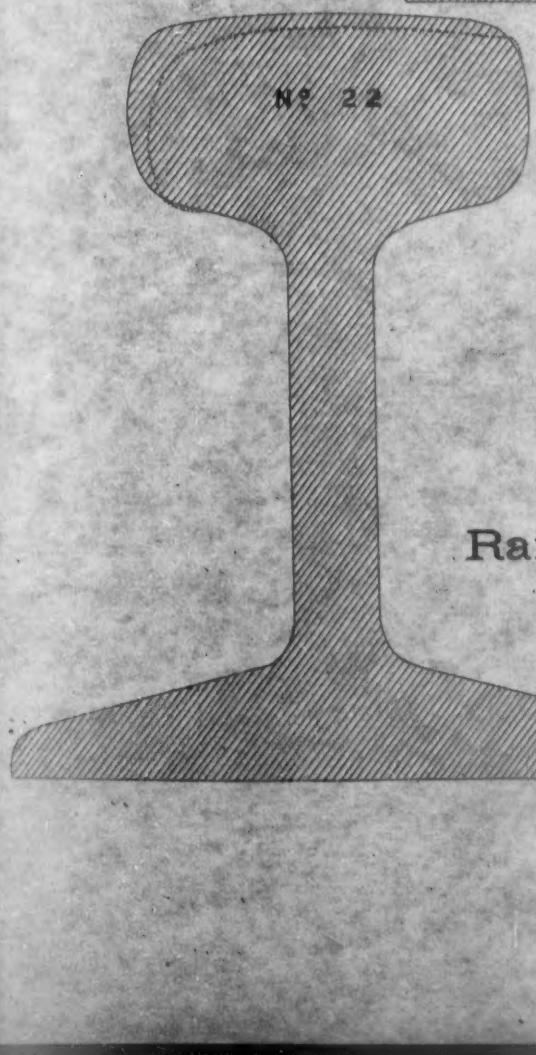












The following references are made to the rail sections which accompany the report of the committee:

No. 1. Iron Rail 62 pounds per yard.

No. 2. Iron Rail 50 pounds per yard.

No. 3. Steel Rail 53 pounds per yard.

No. 4. Steel Rail 56 pounds per yard.

No. 5. Form for steel Rail proposed by Mr. O. Chanute, C. E., — pounds per yard.

No. 6. Rail adopted by Mr. Sayre from the Easton & Amboy Railroad, weight 65 pounds per yard. Same pattern for iron and steel.

No. 7. Section of 56 pound rail now in use on outside of curve near frog south of bridge over the Passaic River, Center street route, Newark. Made by John Brown & Co., and has been in use four years.

No. 8. Section of 53 pound rail in use on straight line in Jersey City yard. Made by John Brown & Co., and has lain four years.

No. 9. Section of 56 pound rail in use on main line at Newark Meadows. Made by John Brown & Co., and has been laid four years.

No. 10. Section of 53 pound rail laid on Belvidere & Delaware Railroad, opposite water station at Lambertville. Made by John Brown & Co. in 1868.

No. 11. Section of 56 pound rail laid on Philadelphia & Trenton Railroad on tangent south of Morrisville. Made by John Brown & Co. in 1868.

No 12. Section of 53 pound rail, laid on outside of curve at South T... Made by John Brown & Co. in 1868.

No. 13. Section of 56 pound steel rail of curve at Bristol Station. ... six years. Made by John Brown & Co.

No. 14. Inside rail of the same curve at the same point.

No. 15. Pennsylvania Steel Company. A W-bb No. 2, 56 pound s... on tangent about a mile south of Bristol. Has been worn four years.

No. 16. John Brown & Co. 56 pound steel rail. Laid on tangent s... north of Eddington Station. Has been in use about five years.

No. 17. Section of 53 pound rail, now in track near north end of ... curve of about 700 feet radius. Made by John Brown & Co., Sheffield, ... in 1868. Worn on one side three years, then turned, and has been w... the present running side, is the outside rail of curve.

No. 18. Bethlehem Iron Co., 62 pounds. Outside rail on curve, a... south of Milford Station, Belvidere & Delaware Railroad. Has b... years.

No. 19. Inside rail of same curve at same point.

No. 20. Bethlehem Iron Company, 62 pounds, outside rail on ... above. Was worn five years on the right-hand side of the rail, then ... been worn a year on the present running side.

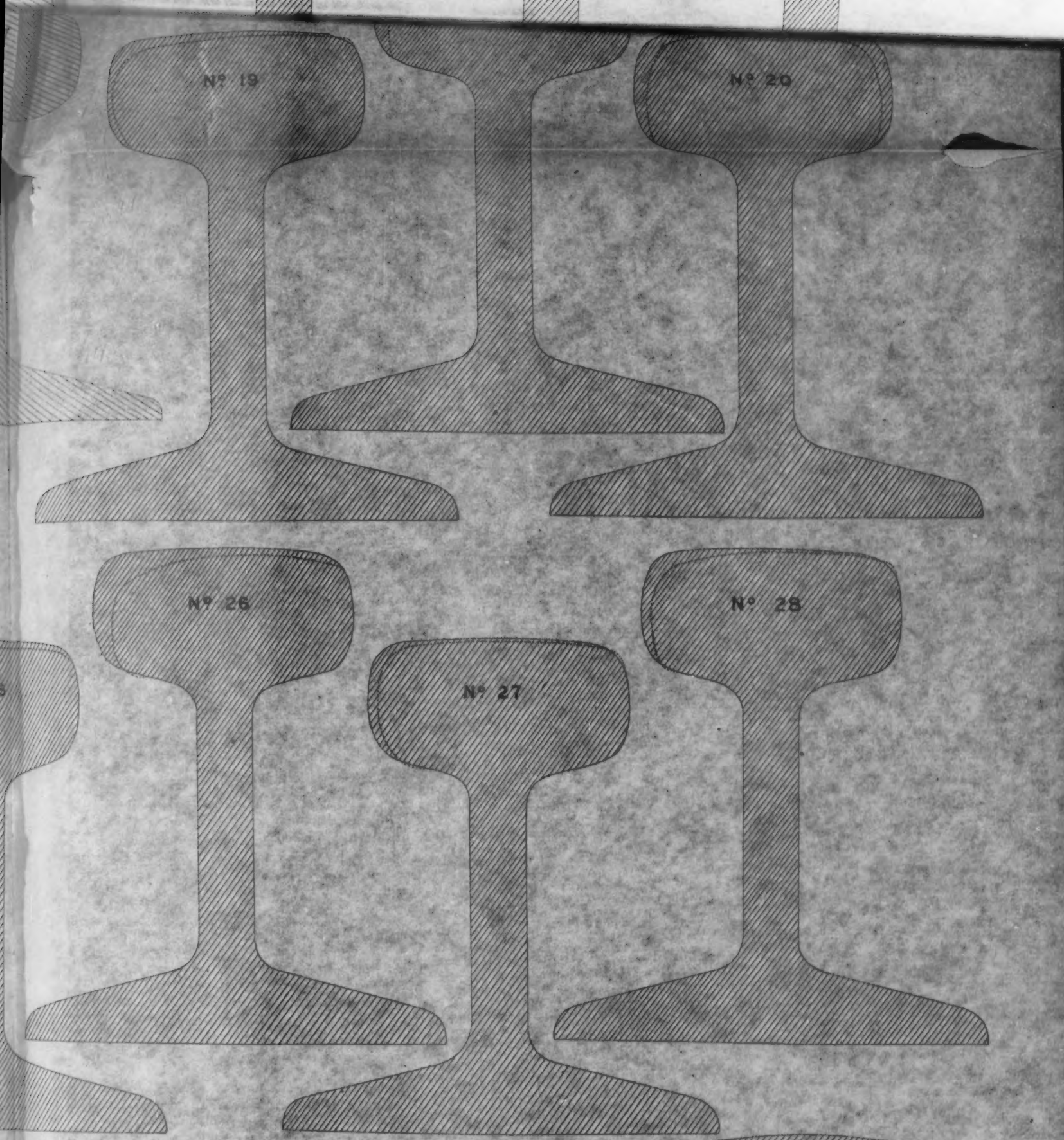
No. 21. Bethlehem Iron Company, 62 pounds. Has been in use ... tangent south of Milford station, where all trains run at full speed.

Rail Sections referred to in the Report of the Committee

ON THE

FORM, ENDURANCE AND MANU

[NOTE.—*In the portion of the Report published in the* GAZETTE *of July* 11 *reference is made to Section "No. 17," which should*



...t to curve at South Trenton Depot.

...re at Bristol Station. Has been in use

...same point.

...W. No. 2. 56 pound steel rail. Laid ...en worn four years.

...rail. Laid on tangent about 2,000 feet ...e about five years.

...rack near north end of Bergen Cut, on ...n Brown & Co., Sheffield, England. Laid ...turned, and has been worn for three on ...ll of curve.

...Outside rail on curve, about two miles ...laware Railroad. Has been in use six

...point.

...ank, outside rail on same curve as ...nd side of the rail, then turned, and has ...e.

...nds. Has been in use six years on long ...trains run at full speed.

No. 22. Bethlehem Iron Company, 62 pounds. Has been in use six years at south end of platform Milford Station, Belvidere & Delaware Railroad.

No. 23. Bethlehem Iron Company, 62 pounds. Has been in use seven years on tangent 1,500 feet north of Frenchtown Station Belvidere & Delaware Railroad.

No. 24. Bethlehem Iron Company, 62 pounds. Has been used seven years on tangent 500 feet south of Frenchtown Station, Belvidere & Delaware Railroad.

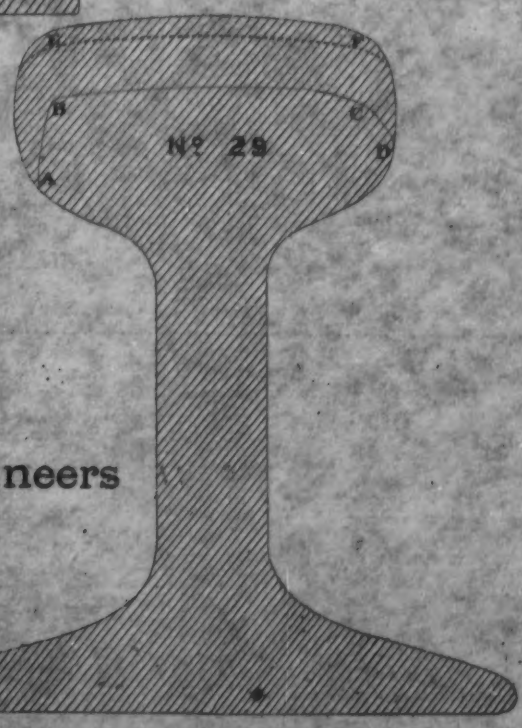
No. 25. Bethlehem Iron Company, 62 pounds. Has been worn seven years on tangent 1,500 feet south of Frenchtown Station, Belvidere & Delaware Railroad.

No. 26. Bethlehem Iron Company, 62 pounds. Laid in the fall of 1869 on outside of curve about half a mile south of Bristol Station.

No. 27. Inside rail of same curve.

No. 28. Bethlehem Iron Company, 62 pounds. Laid in the spring of 1869 on tangent 1¼ miles south of Bristol.

No. 29. Rail used on Lehigh Valley Railroad at Wetherly. ABCD shows the shape of head after 10 years wear. AEFD shows original shape of head as restored by calculation. Steel rail originally weighed 56 pounds per yard, reduced by wear to 48 74-100 pounds per yard. On further investigation the officers in charge of "maintenance of way," Lehigh Valley Railroad, say that the section as restored is about 1-10 of an inch too high, and that the original weight was probably only 56 pounds per yard, which would give the section shown by the dotted line. Area of the section bounded by the upper dotted line 5 6-10 square inches. Area of the section of rail as worn 4 97-100 square inches.



...mittee of the American Society of Civil Engineers

THE

MANUFACTURE OF RAILS.

... 17," which should have been No. 29, and in a foot note reference is made to "No. 5," which should have been No. 6.)

U. OF M.

coal, and that anthracite costs $5 and Cumberland $7 per ton (of 2,240 pounds), then the relative cost for doing this work would be $15 with anthracite and $14 with Cumberland, so that in that case the latter would be the cheapest. This method would also give a ready means of determining the relative economy of different engines, which is impossible when their fuel consumption per mile run alone is compared, as one of them may be run with very light trains, and the other with very heavy ones, and the one employed on a very crooked and the other on a very straight road.

This method of keeping locomotive accounts would only make it necessary to put in addition to the present statistics an account of the number of cars hauled, and when once the average resistance of trains was determined, the calculation of the number of mile-pounds of work done would be very simple and could be done with very little labor. Of course on many roads it would be necessary to determine the resistance for each division, and, in some cases, the local business might cause some confusion, but a little skill in adapting the plan to the existing circumstances would, we believe, overcome all practical difficulties.

We have already called attention to the amount of saving which has been effected in marine engines and the way in which it has been accomplished. Many of the methods employed for this purpose are of course inapplicable to locomotive engines, but there is nevertheless abundant field for improvement. Considering the fact that the fuel consumed on one line last year cost over a million and a half of dollars, it certainly would be worth while to know accurately what becomes of it, and what amount of work or service is performed by each ton consumed, which is impossible with the existing system.

It is also very important that locomotives should be made to perform the maximum amount of service of which they are capable. The cost of enginemen, firemen and conductors of trains is not increased any if 40 freight cars are hauled instead of 30. There is very little difference in the cost of oil and tallow, or of waste and rags. These items, exclusive of conductors, amount, on the road referred to, to over a million dollars. Of course in passenger-car service, and in some freight service the number of cars in a train cannot be increased, or at least only to a very slight extent. If we assume that one-half of the trains could be increased in size without detriment to the traffic, then if the capacity of the engines was increased 10 to 20 per cent., the expenses referred to would be reduced in a like ratio, which would in the case we have selected amount to $50,000 or $100,000 per year.

Now it will be observed that by the system of preparing accounts which is proposed, the heavier the trains hauled the better will be the results shown by the locomotive service, whereas by the present method of keeping these accounts the lighter the trains are the better is the showing which can be made by the locomotive department. If the locomotive service is estimated by the train-mile above, without reference to the work done, then of course the lighter the train the less will be the cost of fuel, repairs, etc., *per train-mile*, which is the ordinary standard of comparison. Master mechanics would therefore, under existing circumstances, be more than human if they did not constantly strive to haul as few cars as possible in order to make the report of their department as favorable as possible. Those who are inclined to be honest and conscientious are, therefore, often placed at a great disadvantage by having their reports compared on the present unjust basis with those of other master mechanics who consult their own interests more and those of their employers less. Considering the fact that in nine cases out of ten no discrimination is exercised by superior officers, and that no explanation will be heeded or understood, it is not surprising, as we have said, that master mechanics should do the best they can for themselves under the existing untoward circumstances.

We invite comment and criticism from experienced persons on the plan suggested.

*Of course our figures are merely hypothetical.

THE PROSPECT FOR TRAFFIC.

Not much comfort is to be had from the reports of earnings which are published. Not only are the receipts small compared with those of last year, but the difference has grown greater as the year has advanced, though the effects of the panic have had time to disappear in a measure, and in some particulars have done so. This, however, is largely owing to the fact that the unsatisfactory earnings of last winter had to be compared with earnings of the previous winter, rendered still more unsatisfactory by the terrible weather, which at once decreased traffic and increased expenses. Last winter was exceptionably favorable for working railroads, and nearly all of the northern lines could then have carried much more traffic than was offered them, while for the two winters previous they were offered more probably than they could carry when in good condition, while the incessant storms greatly limited their capacity. But month after month we have seen the comparison with the earnings of 1873 grow worse and worse; quite as significant as anything, perhaps, is the withholding of reports of earnings by several roads, which is not uncommon with American companies when earnings are unfavorable, though it is not right to accept such withholding as proof of a decrease. Indeed, more could be made, if that were an object, at such a time as this, by the persons familiar with the business of a road, by withholding reports of earnings while they were rising; and if we take it for granted that managers withhold earnings for the purpose of affecting the stock market, we should not forget that they may be interested in having prices fall as well as rise. However, the company which has increasing earnings at this time is so rare a phenomenon that we are justified in assuming that earnings are most commonly withheld now because they look so ill rather than because they look so well.

The one favorable feature of business for the past six or eight months is the decrease in expenses. Labor is generally cheaper, iron is much cheaper, and so are most materials and supplies. Moreover, when the panic came most of the older railroads were prepared to carry the exceptionally heavy traffic which had been pressing them for a year or two, and with the exceptionally light traffic since that time they have been able to dispense with the usual proportion of expenditures for maintenance and renewals. Not a few of them, apparently, have done much more than this. They have permitted the good condition of road and equipment of last September to change to nearly the worst permissible in this July, and bills for supplies and labor to accumulate at the same time. We may exclaim that this is unjust and false economy, but the managers who have kept their companies out of bankruptcy solely by such measures will hardly mind that: they have not done what they would, usually, but what they could, and a corporation cannot pay even just debts without money any more than an individual.

But though there has been doubtless a legitimate decrease in working expenses, aside from this illegitimate one made by starving the road which must be paid for dearly hereafter, and though this decrease per unit of traffic is sometimes considerable, still we must remember that a very large part of a company's expenses, especially those of a company heavily bonded, like most of our American companies, is fixed, and does not decrease with a decrease of traffic. Thus when we consider the interest charges of a company, we may find that the divisible surplus has decreased simultaneously with a large decrease of nearly all the elements which entered into working expenses. A company which last year carried 100,000,000 tons one mile needed to earn net but 0.7 cents per ton per mile in order to meet an annual interest charge of $700,000, and with working expenses 1.6 cents and receipts 2.4 cents it has a surplus of $100,000 for dividends. Now if this year its traffic is reduced to 75,000,000 ton-miles, even with the same receipts per ton per mile and working expenses reduced one-eighth, or to 1.4 cents, it will earn a surplus of but $50,000 over interest charges.

This doubtless is the experience of a great many railroad companies. All find a material decrease in most of the elements of working expenses. Not a few find this decrease so great as to make the proportion of working expenses to receipts smaller and, where rates have been maintained, the net earnings per unit of traffic larger; but many, in consequence of the decrease in the bulk of their traffic and amount of their earnings, and the large interest charged, which unfortunately will not decrease with a decrease of traffic, find a large decrease in the divisible surplus—a decrease so large in many cases as to destroy it.

We are thus compelled to confess that the condition of railroad property has not been favorable. The strong companies—that is most of them, though probably not the strongest—have seen the surplus which supplies dividends on shares decrease and in some cases disappear, and the weak ones have had all or more than they could do to meet their interest charges. The reduced prices have been favorable to them in reducing expenses, but the reduced business activity, of which the low prices are one of the signs, has generally more than balanced this saving by a reduction in traffic and in receipts. If this condition of things were permanent, we would have reason to despair of our railroad companies. Many of them counted prosperous and with a large and important traffic would in time become bankrupt. The kind of "economy" practiced on some of the poorer roads—on more than "some," we fear, and on some not usually called poor—cannot last more than a year or two, or three, when it leaves the property almost disabled. We are justified, therefore, in looking anxiously for the end of this condition of affairs, and observing all the circumstances which are likely to change it for the better.

And we think that we can see them, that they are numerous, significant and likely to have speedy effect. That railroad business everywhere will be revolutionized it is not reasonable to expect. The general business, especially the manufacturing business, of the country has been too profoundly and generally affected to recover in a moment. We will be satisfied if we see such a revival as will give it an effective impulse toward recovery.

It is true that our hopes are based chiefly upon the products of a single industry, but that industry is agriculture, which in this country more than most others lies back of and supports all industries. It is now late enough to determine with something like certainty the production of small grains in the United States; the reports are quite

RAILROAD EARNINGS, JUNE, 1874.

Name of Road.	Mileage. 1874.	1873.	Inc.	Dec.	Per c.	Earnings. 1874.	1873.	Increase.	Decrease.	Per c.	Earnings per Mile. 1874.	1873.
Atlantic & Great Western	571	539	32	.....	6	$ 413,302	$ 423,514	.....	$ 10,212	2½	$ 724	$ 786
Atlantic & Pacific and leased lines	738	799	.....	61	7⅝	404,560	374,769	$ 29,791	.....	8	548	469
Burlington, Cedar Rapids & Minnesota	424	334	90	.....	27	91,205	96,696	.....	5,491	5⅝	215	290
Central Pacific	1,218	1,218	.....	.....	.....	1,380,000	1,301,203	78,797	....	6⅛	1,133	1,068
Chicago, Milwaukee & St. Paul	1,399	1,399	....	.....	.....	886,900	929,211	.....	42,311	4½	634	664
Cleveland, Columbus, Cin. & Ind	470	470	.....	.....	.....	330,754	403,721	.....	72,967	17⅝	704	859
Denver & Rio Grande	118	118	.....	.....	.....	38,083	38,385	.....	302	0¾	323	325
Erie	971	971	.....	....	.....	1,578,945	1,731,592	.....	152,647	8⅞	1,626	1,783
Illinois Central	1,109	1,109	.....	.....	..	678,728	742,600	.....	63,872	8⅝	612	670
Indianapolis, Bloomington & W't'n	344	319	25	.....	7⅞	130,164	136,178	.....	6,014	4⅜	378	427
Kansas Pacific	761	672	89	.....	13¼	316,339	312,614	3,725	.....	1⅛	416	465
Missouri, Kansas & Texas	786	641	145	....	22⅝	237,420	249,343	.....	11,923	4⅞	302	389
Michigan Central	787	787	.....	.....	.....	581,782	608,955	.....	27,173	4½	739	774
Mobile & Ohio	522	517	5	.....	1	120,407	148,691	.....	28,284	19½	231	288
Ohio & Mississippi	393	393	.....	.....	.....	294,838	290,677	4,161	.....	1⅜	750	739
St. Louis, Alton & Terre H., main line	266	266	.....	.....	.....	98,363	116,365	.....	18,002	15½	370	437
" " " branches	71	71	.....	.....	.....	43,226	48,956	.....	5,730	11⅝	609	690
St. Louis, Iron Mountain & Southe.n	685	469	216	.....	46	238,610	216,223	22,387	.....	10⅜	348	461
St. Louis & Southeastern	349	349	....	.....	.....	96,939	119,020	.....	22,081	18½	278	341
Toledo, Peoria & Warsaw	237	237	.....	.....	.....	84,358	111,686	....	27,325	24½	356	471
Toledo, Wabash & Western	628	628	....	.....	.....	388,535	541,192	....	152,657	28¼	619	862
West Wisconsin	197	197	.	.....	.....	74,937	71,135	3,802	.....	5⅜	380	361
Totals	13,044	12,503	602	61	.....	$8,508,395	$9,012,723	$142,663	$ 646,991	.....	$652	$721
Total increase or decrease	.....	.....	541	.....	4¾	.....	.....	.....	504,328	5⅝	.....	.....

RAILROAD EARNINGS, SIX MONTHS ENDING JUNE 30.

Name of Road.	Mileage. 1874.	1873.	In.	Dec	Per c.	Earnings. 1874.	1873.	Increase.	Dec.	Per c.	Earnings per mile. 1874.	1873.	Inc.	Dec	Per c.
Atlantic & Great Western	571	539	32	....	6	$ 2,422,037	$ 2,442,605	.....	$20,568	0⅞	$4,242	$4,532	...	$290	6⅜
Atlantic & Pacific and leased lines	738	799	....	61	7⅝	2,287,890	2,372,960	.....	85,070	3⅝	3,100	2,970	$130	..	4⅜
Burlington, Cedar Rapids & Minn.	424	334	90	....	27	540,277	481,807	$58,470	.....	14⅛	1,274	1,442	....	168	11⅝
Central Pacific	1,218	1,218	...	...	.....	6 407,926	6,325,408	81.618	.....	1⅓	5,260	5,193	67	....	1⅓
Chicago, Milwaukee & St. Paul	1,399	1,399	....	....	.....	4,481,945	3,622,989	858,956	.....	23¾	3,204	2,590	614	....	23¾
Cleveland, Col., Cin. & Indianap.	470	470	....	....	.....	1,956,692	2,441,819	.....	486,127	19⅞	4,161	5,195	...	1034	19⅞
Erie	971	971	....	....	.....	8,880,915	9,526,807	.....	645,892	6¾	9,146	9,811	....	665	6¾
Illinois Central	1,109	1,109	....	....	.....	3,593,100	3,792,400	.....	199,300	5¼	3,240	3,420	....	180	5¼
Indianapolis, Bloomington & W.	344	319	25	....	7⅞	823,021	697,319	125,702	..	18	2,393	2,163	230	....	10⅝
Kansas Pacific	761	672	89	....	13¼	1,519,681	1,643,735	.....	124,054	7⅝	1,997	2,446	...	449	18¾
Missouri, Kansas & Texas	786	641	145	....	22⅝	1,435,525	1,440,900	...	5,375	0⅜	1,826	2,248	....	422	18¾
Michigan Central	787	787	....	....	.....	3,757,186	3,672,052	85,134	....	2⅜	4,774	4,666	108	....	2⅜
Mobile & Ohio	522	517	5	....	1	1,084,271	1,398,607	.....	314,336	22½	2,077	2,705	...	628	23¼
Ohio & Mississippi	393	393	....	....	.....	1,666,900	1,850,658	.....	183,749	9⅞	4,242	4,709	...	467	9⅞
St. Louis, Alt. & T. H, Main Line	266	266	..	....	.....	575,446	698,510	.....	123,064	17⅝	2,163	2,826	....	663	17⅝
" " " Branches	71	71	....	....	.....	246,069	296,125	.....	50,056	16⅞	3,466	4,171	....	705	16⅞
St. Louis, Iron Mountain & So.	435	349	86	....	24⅝	1,126,230	1,201,464	.....	75,234	6¼	2,589	3,443	...	854	24¾
St. Louis & Southeastern	349	349	....	..	.....	598,812	640,939	.....	42,127	6⅝	1,716	1,836	....	120	6⅝
Toledo, Peoria & Warsaw	237	237	....	....	.....	549,443	568,518	.....	19,075	3⅜	2,318	2,399	....	81	3⅜
Toledo, Wabash & Western	628	628	....	....	.....	2,477,293	2,705,018	.....	227,726	8⅜	3,945	4.307	....	362	8⅜
Totals	12,479	12,068	471	61	.....	46,428,767	47,820,640	$1,209,880	2,601,753	.....	$3,721	$3,963	....	$242	6⅛
Total increase or decrease	.....	.....	411	....	3⅜	.....	.....	.....	1,391,873	2⅞	.....	.....	....	.....	.....

full from all parts of the country, and a large amount and good condition of the crops seems almost universal—so nearly so that the destruction of vegetation by grasshoppers in a few thinly-peopled counties of Minnesota and Iowa seems almost the only exception and will have a most trifling effect on the production of the country as a whole. In California the harvest is largely over, and that single State will have very nearly 25,000,000 bushels of wheat *for export* against about 15,000,000 last year.

Corn in most of the country has still a chance of failure, but it is a slight one, and its condition now in the Northwest is such as to indicate a larger crop than ever before, more than that of 1872, which glutted the market. This is one of the most important of crops to the carriers as well as the farmers, for on it largely depends the amount of cattle and hog shipments and products. Cotton is something not safely counted till it is ready to pick, but the reports indicate a considerably better promise than at this time last year, with a much larger production of cereals in the cotton districts.

Now these large crops—unexampled in abundance if there are not great errors in the reports—mean for the railroad companies immense shipments during the next twelve months of wheat, corn, cotton, flour, cattle, hogs and provisions, an average high degree of prosperity among the farmers, and probably an increase in their purchases and in the traffic towards as well as from them. For a very large part of the railroads of the country agricultural prosperity is their own prosperity. The farmers' products fill their trains in one direction and the farmers' supplies in the other. Moreover the effect of an extraordinary crop is immediate; they feel it quite as soon as the farmer, as they carry it almost as soon as money is paid for it, or before.

The back traffic on these roads, however, and the general business and traffic of the country are affected by the price as well as the amount of the farmers' products. If with the exceptionally large production prices should be maintained, we would not hesitate to prophesy a general revival of business, a large and healthy demand for most of our manufactured products, and a wide-spread prosperity which would extend to the railroads of all sections of the country. A good crop in America is compatible with high prices doubtless, for America is not the world, and it is the proportion of the world's demand to the world's supply that determines prices. But if we look over the rest of the world we will see that, so far as grain is concerned, the prospect is generally very good outside of America.

Although it is not late enough to say that the European crops have escaped all possible accidents, still the chances are now very small. The latest information is that the crop of France is good; that of Hungary, one of the great sources of supply for Northern Europe, fully up to the average; that of Southern Russia, which is our great competitor for the supply of England, promising very well; while that of England, which is harvested so late that its prospects may greatly change in the interval, is now in at least fair condition. Europe apparently will not need more than the average importations of breadstuffs, if as much, to supply it fully, and our farmers may find the value of their great crop not so much greater than that of previous smaller ones. Now this is not a misfortune for the world; it is good fortune and only good; but it may be a misfortune for Northwestern grain-growers, and to that great army whose support comes from making and selling supplies to these grain-growers.

But whatever the price may be, large crops are sure to give the railroads which carry from the producer to the consumer a large traffic. If the price is good this will give them a much larger traffic and will extend the activity to almost all lines and all branches of business. And with low prices the revenue from the crops is likely still to be larger than usual and to begin at least a stimulation of general business.

When the business of "moving the crops" begins, as it will in the Northwest before the end of next month probably, we may expect, if there is the ordinary activity in marketing grain, to find a large number of roads encumbered with traffic. They have not increased their rolling stock for a year because there was no need of it, and they have in many cases permitted it to get into bad condition, as likewise the road, and a sudden and large increase in traffic is likely to make evident all the negligences of the year. It is reasonable to believe that these sudden necessities will create a demand for rolling stock and supplies such as has not been known for many months. How far this demand will extend must depend, of course, upon the number of lines on which the season's crops will increase traffic beyond the present facilities, and that, as we have endeavored to show above, depends largely on the price as well as the amount of the crops.

Another effect of an exceptionally large crop, if it is accompanied by exceptionally low prices, is to be expected and deprecated by the railroad companies, and that is a renewal and increase of the hostility of the producers. Ever since the war, whenever the market has been glutted with any leading product, especially corn, with which, on account of the limited available demand, the market can easily be glutted, the losses of the farmers by reason of low prices have been charged upon the railroad companies. A corn crop this year in excess of the demand, bringing down prices so low that from many parts of the country which usually sell that grain it will not pay to ship it, would, we fear, in the minds of a great mass of people, be considered proof that the charges of the railroad companies were extortionate; and that feeling might exist none the less should the railroad companies carry that particular product entirely without profit. This, however, is something which we shall have to bear whenever there is an excessive production of any low-priced material until there is a more general knowledge of the circumstances which affect the business of railroad transportation, the teaching of which in one way or another is likely to form an important part of the duties of railroad officers for some time to come.

Record of New Railroad Construction.

This number of the RAILROAD GAZETTE has information of the laying of track on new railroads as follows:

Pawtuxet Valley.—Completed from River Point, R. I., northwestward 3½ miles to Hope Village. *New York & Canada.*—Completed from Whitehall, N. Y., northward 24 miles along the west shore of Lake Champlain to Ticonderoga. *Buffalo Valley.*—Completed from the Pittsburgh, Washington & Baltimore road at Garrett's northeastward 10 miles to Berlin, Pa.

This is a total of 37½ miles of new railroad, making 727 miles completed in the United States in 1874.

JUNE EARNINGS, as our table shows, indicate a progress backward at an accelerated rate. Of the 22 roads reporting sixteen show a decrease in gross and nineteen in earnings per mile of road. The 13,044 miles reporting earned $504,328 less than the 12,503 miles in 1873, and the earnings per mile have fallen off from $721 to $652, or 9⅝ per cent.

For the six months we have reports from twenty companies with 12,479 miles of road—411 miles more than last year. Five of the twenty show an increase in total earnings, and there is a total decrease of $1,391,873, the receipts per mile falling from $3,963 to $3,721, or 6⅛ per cent. Perhaps the decrease in receipts is accompanied by an equal decrease in working expenses on the whole, but this cannot be true in all cases, and some companies must be suffering severely.

The Reported New Pass Over the Raton Mountains.

ATCHISON, TOPEKA & SANTA FE RAILROAD,
TOPEKA, Kan., July 7, 1874.

TO THE EDITOR OF THE RAILROAD GAZETTE:

Your issue of July 4 contains a statement taken from *The Cimarron* (New Mexico) *News*, saying that a surveying party of the Atchison, Topeka & Santa Fe Railroad Company has discovered a new pass over the Raton Mountains near Trinidad, Colorado.

This company has no such "surveying party" in its employ.

The remaining statements are doubtless equal in truthfulness to the one here corrected.

A. A. ROBINSON, Chief Engineer.

General Railroad News.

ELECTIONS AND APPOINTMENTS.

—Mr. J. A. Roblin has been appointed Train Dispatcher and Chief Operator on the Sacramento Division of the Central Pacific Railroad.

—The new board of directors of the Rochester & State Line Railroad Company met in Rochester July 14 and elected the following officers: George A. Whitney, President; Oliver Allen, Vice-President; George E. Mumford, Treasurer; Donald McNaughton, Secretary and Assistant Treasurer; Edward Harris, Attorney; C. S. Masten, Chief Engineer. Executive Committee: George A. Whitney, D. D. S. Brown, M. F. Reynolds, William Bristol, George E. Mumford. Finance Committee: Charles F. Smith, Edward Harris, Oliver Allen.

—Mr. William H. Stephenson, late Assistant Paymaster on the New York Central & Hudson River has been appointed Superintendent of the Shore Line Division of the New York, New Haven & Hartford Railroad in place of the late Mr. Wilcox.

—Col. J. W. McClure, of Lewisburg, Tenn,, has been chosen President of the Duck River Narrow-Gauge Railroad Company, in place of L. D. Myers, resigned.

—At the annual meeting of the Grand Rapids & Indiana Railroad Company in Fort Wayne, Ind., July 15, the following directors were chosen: W. O. Hughart, Grand Rapids, Mich.; J. G. Wait, Sturgis, Mich.; P. Hoagland, F. P. Randall, Fort Wayne, Ind.; M. Talcott, Chicago; J. N. McCullough, Thomas D. Messler, Wm. Thaw, Pittsburgh; Thos. A. Scott, Geo. B. Roberts, John P. Green, Philadelphia; Robert B. Potter, New York; H. J. Jewett, Columbus, O.

—The United States Circuit Court has appointed E. B. Thomas, of Cleveland, O., Receiver of the Lake Shore & Tuscarawas Valley Railroad. Mr. Thomas continues all the executive officers of the road in their positions.

—Mr. D. G. Moore, of Springfield, Ill., has been appointed Paymaster of the Illinois Division of the Toledo, Wabash & Western Railway.

—At a meeting of the new board of directors of the Lafayette, Muncie & Bloomington Railroad Company, held at Lafayette, Ind., July 8, John W. Heath was elected President; James B. Fally, Vice-President; O. W. Pearce, Treasurer; A. J. Castalor, Secretary.

—Mr. David McCargo, of Pittsburgh, Pa., has been appointed Receiver of the Oil Creek & Allegheny River Railroad in a suit brought by the bondholders. He has appointed the following officers: C. J. Hepburn, Superintendent, Oil City, Pa.; F. A. Phillips, Treasurer, Corry, Pa.; T. F. Brown, Auditor and General Ticket Agent, Corry, Pa.; M. Crosby, Solicitor, Corry, Pa. The only change made in the officers is that Mr. Brown, late Chief Clerk in the ticket office, is made General Ticket Agent, an office formerly held by the Treasurer, Mr. Phillips. Mr. Hepburn has had charge of the road, as Assistant Superintendent, heretofore, Mr. Lawrence, of the Allegheny Valley, having been General Superintendent.

—Mr. W. C. Browe has been appointed Assistant General Ticket Agent of the Marquette, Houghton & Ontonagon Railroad, with office at Marquette, Mich.

—Governor Talbot, of Massachusetts has appointed the following gentlemen as members of the Hoosac Tunnel Commission: Alexander H. Bullock, Worcester; Samuel C. Cobb, Alanson W. Beard, Boston; Paul A. Chadbourne, Williamstown; Stephen M. Crosby, Northampton. Governor Bullock, however, declines to serve on the Commission.

—Judge Kilpatrick, of Mississippi, has been elected President of the Corinth & Nashville Railroad Company.

—Mr. J. C. Lopez, heretofore General Freight and Ticket Agent of the Memphis & Charleston Railroad, has been relieved of the charge of the Passenger Department and will be hereafter General Freight Agent. Mr. M. S. Jay has been appointed General Passenger and Ticket Agent.

—Mr. Theodore N. Ely, late Superintendent of Motive Power of the Philadelphia & Erie, has been appointed Superintendent of Motive Power of the Pennsylvania Railroad, in place of Mr. Frank Thomson, made General Manager.

TRAFFIC AND EARNINGS.

—The earnings of the Denver & Rio Grande Railway for the first week in July were: 1874, $8,697; 1873, $9,296; decrease, $599, or 6½ per cent.

—The earnings of the Burlington, Cedar Rapids & Minnesota Railroad for the first week in July were: 1874, $22,548; 1873, $21,911; increase, $637, or 3 per cent.

—The earnings of the Atlantic & Pacific Railroad and leased lines for the first week in July were: 1874, $87,221; 1873, $71,940; increase, $15,281, or 21¼ per cent.

—The earnings of the Great Western Railway of Canada for the week ending June 26 were: 1874, £19,625; 1873, £22,949; decrease, £3,324, or 14½ per cent.

—The earnings of the Grand Trunk Railway for the week ending June 27 were: 1874, £39,800; 1873, £37,200; increase, £2,200, or 5⅞ per cent.

—The earnings of the Great Western Railway of Canada for the week ending July 3 were: 1874, £19,724; 1873, £24,306; decrease, £4,582, or 18⅞ per cent.

—The earnings of the Atlantic, Mississippi & Ohio Railroad for April were: 1874, $135,914; 1873, $203,355; decrease, $67,441, or 33⅓ per cent.

—Of the flour and grain shipped eastward from the lake ports during the week which ended July 11, 46 per cent. of the flour, 22½ per cent. of the wheat, 42 per cent. of the corn and 82 per cent. of the oats went by rail.

—The grain shipments from the six Western lake ports and St. Louis from August 1, 1873, to July 11 were 173,192,726 bushels, against 145,913,787 for the same period the previous year, he increase being 19 per cent.

OLD AND NEW ROADS.

Philadelphia & Reading.

This company now owns the old line of the Philadelphia, Wilmington & Baltimore from Philadelphia to Chester and also controls the Chester & Delaware River road, a short line which runs from Chester southwardly along the Delaware shore to Thurlow. This latter company recently resolved to construct a branch line to pass through Marcus Hook and connect with the Philadelphia, Wilmington & Baltimore near the Delaware line. It is also stated that surveys have been made from Marcus Hook to Wilmington, Del., entering that city north of the present road. All these things have given rise to a report that the Reading Company means to extend its Chester line to Wilmington, possibly to compete with the Baltimore road, more probably to establish a southern outlet under its own control for its coal trade and perhaps to injure the new coal line to Wilmington formed by the Wilmington & Reading and Berks County roads. Nothing definite is, however, known as to its real intentions.

The Great Western Investigation.

The Board of Directors of this company have not been willing to remain quiet under the charges of the Investigating Committee until a meeting can be held, but have published a statement in which they say that they will call a meeting and submit a full answer at the earliest day possible, that they repudiate the assertions affecting the directors personally "as conveying most unworthy and unfounded insinuations," that they are astonished at the summary of the report made by the committee's engineer, which stated that the permanent way, works and bridges were not in a satisfactory condition, and that they at once ordered that two of the most eminent and independent railroad engineers to be found in Canada and the States be engaged to make an inspection and report. The directors also publish correspondence in which they asked the Investigating Committee for the evidence on which its charges concerning the directors' use of their privileges for stock-jobbing was based and also for a full copy of the engineer's report, of which the committee has published but a summary, both of which requests the committee refused to comply with.

Quebec Railroad Aid.

The Province of Quebec sold in London during the first week of this month £800,000 of its 5 per cent. sterling bonds, the proceeds of which are to go to the various railroads to which it has voted subsidies. The price was 97½. The province had no debt before.

Atlantic & Great Western.

This company asks holders of its first-mortgage bonds to accept "deferred warrants" bearing 4 per cent. interest and payable from the rental to be received from the Erie for their overdue coupons.

Chicago & Superior.

Hon. James Campbell, the President, writes from England, where for several months he has been trying to negotiate a loan for this company, that the Potter law "has practically closed the European market against all Wisconsin securities."

Oil Creek & Allegheny River.

On application of the trustees under the consolidated mortgage, on which bonds the May interest is unpaid, the Pennsylvania Circuit Court at Meadville has appointed David McCargo, of Pittsburgh, Receiver, and has placed him in possession of the road. Mr. McCargo was Superintendent of the road some years ago. It is stated that the intention is to foreclose the mortgage and re-organize the company, and that the stockholders will offer no serious opposition.

United States Contracts.

Major D. C. Houston, Corps of Engineers, U. S. A., will receive sealed proposals in duplicate at his office, No. 154 Lake street, Chicago, for the improvement of the following lake harbors, the bids to be handed in by noon of the 4th of August: Marquette Harbor, Michigan; Menomonee Harbor, Michigan and Wisconsin; Green Bay Harbor, Manitowoc Harbor, Sheboygan Harbor, Milwaukee Harbor, Racine Harbor, Kenosha Harbor, Wisconsin; Chicago Harbor, Calumet Harbor, Illinois; Michigan City Harbor, Indiana.

Major Godfrey Weitzel, Corps of Engineers, will receive pro-

posals at his office in Detroit, No. 85 Washington avenue until 3 p. m. of August 15 for the following harbor and river improvements:

Harbor of Refuge, at Sand Beach, Mich., crib work in continuation of that now in progress.

Sheboygan Harbor, Lake Huron, Mich, dredging in continuation of the present improvement.

Mouth of Black River, in St. Clair River, Mich., dredging in continuation of the present improvement.

Saginaw River, Mich., pile revetment and dredging.

Lieut. Col. J. D. Kurtz, Corps of Engineers, will receive proposals at his office, No. 1,328 Chestnut street, Philadelphia, until noon of August 17, for the following works:

For removing, by dredging, from the bar in the Delaware River near Fort Mifflin 173,000 cubic yards of sand, mud and loose material.

For removing, by dredging, about 70,000 cubic yards of sand and gravel from the channel of the Schuylkill River above Penrose Ferry Bridge.

For removing from the channel of Christiana River (Wilmington, Del., Harbor) 135 cubic yards of solid rock.

Major Wm. P. Craighill, Corps of Engineers, will receive proposals at his office, Bank Building, Fayette near Charles street, Baltimore, Md., until noon of July 30, for dredging in the Patapsco River.

Capt. A. N. Damrell, Corps of Engineers, will receive proposals at his office, No. 38 Church street, Mobile, Ala., until noon of August 22, for dredging 10,000 cubic yards, more or less, through the bar at the mouth of the harbor of Cedar Keys, Fla.

Milwaukee, Lake Shore & Western.

The general offices have been removed from Manitowoc, Wis., to Milwaukee, where they are located at No. 115 Wisconsin street.

Buffalo Valley.

Track is now laid on this road from Berlin, Pa., southwest to Garrett's Station on the Pittsburgh, Washington & Baltimore road. It is about 10 miles long, and will be worked as a branch of the latter road. It is said to open a valuable country.

Chicago & Southern.

This company, which is to build an entrance into Chicago for the Chicago, Danville & Vincennes, has commenced proceedings in the Circuit Court for the condemnation of the land required for the road.

Visalia Branch.

The contract for grading and tracklaying has been let to Daniel Spangler, the work to be completed by August 15. The road is 7¼ miles long, from Visalia, Cal., to a junction with the Visalia Division of the Central Pacific. Work was begun July 6.

The Cawood Swage Block.

The United States Circuit Court in Chicago has finally given its decision in the suit of the holders of the Cawood Swage Block patent against various companies for infringement. The sums awarded by the master's report are considerably reduced, the total amount given being $419,162.31, the master's report giving about $700,000. The judgments against the different companies are as follows: Lake Shore & Michigan Southern, $222.661.89; Illinois Central, $91,980.33; Chicago, Burlington & Quincy, $34,594.83; Chicago & Alton. $36,226,38; Pittsburgh, Fort Wayne & Chicago, $33,698.80.

The invention is a swage block used in repairing the ends of rails, and the amount awarded for infringement is the amount which, the Court holds, the companies have saved by using this swage-block instead of the old method.

Cincinnati Southern.

Notice is given that the trustees have submitted to the Secretary of War for his examination the necessary plans and maps for a bridge across the Ohio River below the mouth of the Big Sandy and near the foot of Horne street in Cincinnati, which bridge is proposed to be built for the use of the Cincinnati Southern road.

Springfield & Tariffville.

Mr. W. H. Barnum, President of the Connecticut Western Company, has intimated that if Springfield will give $300,000 or $350,000 he will build this season the line from Springfield, Mass., southwest to Tariffville, Conn., there to connect with the Connecticut Western road.

Southern Minnesota.

The bondholders' committee announces that four-fifths of all the 8 per cent. construction bonds have been deposited with the Farmers' Loan & Trust Company in New York. In order to enable all the bondholders to come in, the time for the deposit of bonds has been extended to August 15.

Lee & New Haven.

The late Massachusetts Legislature passed a bill providing for a commission of three members to be appointed by the Governor to examine into the affairs of this company and its claims for a renewal of the State aid grant, which lapsed some years ago. The commission is to report to the next Legislature. The Governor has appointed Horatio G. Knight of Easthampton, Milton B. Whitney of Westfield, and James M. Shute of Somerville as members of the commission.

New York & Eastern.

The question of giving this company authority to build a bridge over the Housatonic River has been finally settled by the Connecticut Senate voting by a decided majority "to give the petitioner leave to withdraw his petition," which is equivalent to a decided rejection.

Fitchburg Union Depot.

The various companies, whose lines enter the city of Fitchburg, Mass., have finally agreed upon the plans for a new union depot there. It is to be of wood, 250 feet long by 25 wide, to be surrounded by a wide platform and to contain all the necessary offices, waiting rooms, etc.

The New Passenger Agreement.

The following is the official text of the combination agreement made between the managers of the four trunk lines of railroads relative to passenger traffic:

Free passes or tickets of any kind will not be issued to any officer for the purpose of influencing traffic.

Return tickets will not be sold at less than full passenger rates to live stock drovers.

Passenger agents are not allowed to issue free passes, and all passes now in their hands are revoked.

The established through passenger rates adopted by the General Passenger and Ticket Agents' Association, with full proportions, will be collected upon all through tickets of every class.

Only 100 pounds of baggage will be transported free upon each ticket sold, and all excess in weight will be charged for at tariff rates.

Summer excursion route, tickets to places of public resort only, may be sold only in June, July, August and September, at rates based upon not less than two cents per mile, and such tickets shall be so issued as not to reduce through rates between business centers, and shall not be sold to or from points west of Buffalo, Niagara, Johnstown, Pittsburgh, Wheeling or Parkersburg.

No other round trip tickets will be issued or accepted.

Through rates from Boston to the west will be advanced to the sum of local rates by way of Albany, except that the maximum difference between Boston and New York rates shall be $4. Through rates from other New England points shall be advanced accordingly.

The Erie, Baltimore & Ohio and Pennsylvania Railroad Companies shall sell tickets from Boston and points on the line and north of the Boston & Albany road at $1 higher by way of New York than the rates by way of Albany.

The same rates shall be adopted eastward and westward.

The remaining articles relate to ticket offices in New York and have been already published. The agreement is signed by the representatives of the Baltimore & Ohio, Pennsylvania, Erie and New York Central & Hudson River companies.

New York Central & Hudson River.

Trouble has arisen with the farmers on the line of the road at Port Byron N. Y. The company recently attempted to take possession of the land required for the third and fourth tracks at that place, but the people of the neighborhood assembled and drove them off. The farmers entrenched themselves and a serious riot seemed probable. The people admit that the company has had the land appraised and condemned, but claimed that it should build a highway bridge over the railroad at that point, or else allow them additional damages for the extra risk and trouble of crossing four tracks instead of two. The company applied for a writ of possession, which would enable it to call on the sheriff for assistance, but the court, after hearing argument, decided that such a writ coulp not be issued under the statute.

Longmont, Fort Collins & Northwestern.

This newly-organized company intends to build a railroad from Longmont, Col., northwestward through Fort Collins, on the Cache-la-Poudre River, to the Union Pacific at Laramie, in Wyoming. The road will be about 140 miles long. The capital stock is to be $1,000,000.

Milwaukee & Superior.

The city of Milwaukee, being now compelled by decisions of the courts to pay the $100.000 of bonds issued in aid of this road, is endeavoring to collect farm mortgages to the amount of $59,000 which were given by people along the line to the company, and by it transferred to the city as security. Naturally there is some complaint among the people.

South Mountain.

An effort is to be made to raise money in Reading, Pa., to build the proposed branch line from this road through the Tulpehocken Valley to Reading, passing through Bernville and Rehrersburg.

Sharpsville & Oakland.

Surveys have been completed and the right of way secured for an extension of this branch of the Erie & Pittsburgh road from its present terminus for three miles down the Neshannock Creek to Bethel. Work is to be begun at once.

Philadelphia & Reading.

The Philadelphia correspondent of the *Iron Age* says:

"We have rumors of an additional railroad competing with the Philadelphia, Wilmington & Baltimore, by the Reading Railroad Company. The latter purchased from the former a year since the portion of the line from Philadelphia to Chester, which, it is now said, will be extended to Wilmington, thus giving a new coal outlet to the great corporation. This proposed road may have something to do with a plan now under discussion to erect a large blast furnace at Wilmington, a point which should have been years ago supplied with furnace facilities.

"The Reading Company is rapidly completing its new ship yard and plate mills at Port Richmond, the buildings for which will be 420 by 100 feet, and one of which will have a molding loft of 60 by 260 feet. The initial expenditure for the enterprise is $600 000, and adjoining the yard will be constructed a dry dock 60 feet wide and 525 feet long, capable of holding any ship afloat, except the Great Eastern."

New York & Long Branch.

It has been resolved to make all the spans of the bridge over the Raritan of iron. The wooden spans of Howe truss that have already been completed will be used for other bridges on the line. The contract for these spans and the four unfinished spans has been let. The bridge will be about 1,000 feet long over all. The construction of the extension from Long Branch to Ocean Grove has also been determined on. The change in the bridge will cause a little delay in the work and it is not likely that the road will be finished before next Spring. The amount of stock which the people along the line were to subscribe for has not quite been made up, the Long Branch subscriptions being still deficient.

Berks County.

It is stated that this company has failed to secure from the Lehigh Valley the facilities for exchange of traffic which were expected. This result is perhaps owing to the opposition of the Philadelphia & Reading Company, which has always worked against this road and the Wilmington & Reading, of which the Berks County is an extension. The company has, however, succeeded in making an agreement for interchange of business and through rates with the New Jersey Central, and the road is to be extended from its present terminus at Slatington, Pa., to a connection with the Central's Lehigh & Susquehanna Division. This extension, which will be 1¾ miles long, has been located and work is to be begun on it at once. This arrangement will give the Central a southern outlet for its coal, and will enable it to establish a coal depot at Wilmington, Del., as well as a connection with the furnaces and factories about Reading.

The Vermont & Canada Sale.

At a recent meeting of the Vermont & Canada stockholders to ratify the sale of the road to the Central Vermont Company, some pretty plain talk was indulged in, of which the following is a specimen:

Mr. Coles—We supposed we had good security when we held the whole property of the Vermont Central to secure our 8 per cent., but it seems it was not secure. We have run off the track somewhere. My idea is that the Vermont & Canada is well worth $5,000,000. I want to understand whether we can get any claim on the property that will secure us.

Mr. Brooks—The Vermont Central has been bankrupt for twenty-one years, and the debts of the receivers are attached to the property. The new corporation is free of any liability, and has a million of dollars in the treasury. They have put it in for the purpose of making more, and not losing it. We have, therefore, the guarantee of a million dollars by this contract to-day.

Mr. Todd—I do not approve of this lease. In the first place, they ask us to give in $500,000 of the back rent. In the second place, we are disposing of this property to a bankrupt corporation. In the third place, I have no confidence in the men with whom we deal. They have asked us a great many times to walk into their parlor, and every time we have gone in we have come to grief. [Laughter.] If we sign this arrangement, in a few years they must break down. They are running the Rutland and Ogdensburg roads in debt half a million a year, and it is out of the question for them to go on. There are two old Christian gentlemen here now, singing their song, asking us to come here and spinning their web; and I am afraid. [Laughter.]

Mr. Coles—As we have the Chancellor against us and the managers against us, I think we had better take the 6 per cent. * * * *

Mr. Bradley Barlow—As one of the present directors of the company, I believe that if your directors had acted in good faith, all this might have been avoided. But you have trusted to them, and by their votes, and the decrees procured by them, we find it impossible to solve this difficulty in any other way. So far as security is concerned, I have great faith to believe that you are in a way to get your rent at 6 per cent. I believe the interests of these gentlemen lie in this direction, and that somebody will pay your rent. How many securities will have to be sacrificed, how many people will be robbed and ruined to do it, I don't know, but I believe you stand a better chance than any one else. All we have to do is to keep firm control of our property. If I had had a majority of the stock I would not have accepted the terms, but the stockholders are scattered, and this is in my opinion the best thing we can do.

Mississippi Valley & Western.

No progress has been made in the extension of this road south of Hannibal, Mo., and some of the friends of the road allege that the delay is due to bad faith on the part of the Hannibal & St. Joseph Company. The latter, it is alleged, has failed to keep its promise to guarantee the Mississippi Valley & Western's bonds, and has thereby prevented them from being negotiated.

The Hoosac Tunnel Line.

Governor Talbot, of Massachusetts, has named as the members of the Tunnel Commission, under the act of the late Legislature, Ex-Governor Alexander H. Bullock, of Worcester, President Paul A. Chadbourne, of Williams College, Mr. Stephen M. Crosby, of Northampton, Mayor Samuel C. Cobb and Mr. Alanson W. Beard, of Boston. Governor Bullock, however, has declined to serve, and the vacant place has not been filled, though Governor Washburn is named as the most probable man.

The commission is to take and hold in trust for one year all the property of the State in the Hoosac Tunnel, Troy & Greenfield, and Southern Vermont railroads, and have power to make contracts extending one year for the transportation of passengers and freight over the roads named, and through the tunnel. The trustees are also to make exhaustive inquiries as to the best plans for the future of the Tunnel, and report the same to the Legislature. The matters for investigation are as to what running arrangements can be made between the Commonwealth as owner of the Tunnel and any railroad corporation of the State, with a view to organize a through route between Boston and the West; also on what terms the railroads connecting with the Tunnel and Troy & Greenfield Railroad as a through line could be purchased or leased by the Commonwealth; also what contracts have been entered into between the Commonwealth and corporations operating any roads connected with said Hoosac Tunnel and Troy & Greenfield Railroad. The recommendations which the commission may make, though of course not final, will undoubtedly have much weight with the Legislature in making a final disposition of the tunnel.

Some delay is anticipated in the opening of the tunnel for business, as it is now proposed to complete all the brick arching before the opening. Meantime much work is to be done in the relocation of the Troy & Greenfield road, so that the tunnel will probably be ready as soon as the tunnel line.

Lake Shore & Tuscarawas Valley.

The United States Circuit Court at Cleveland, O., has placed this road in the hands of a receiver. Mr. E. B. Thomas has been appointed to that position and has taken possession of the road.

The road is 100 miles long, from Black River, O., on Lake Erie, south by east to the Pittsburgh, Cincinnati & St. Louis at Uhrichsville, and was completed in 1872. The company has been in embarrassed circumstances for some time. From the statement submitted to the stockholders at the recent annual meeting it appears that the floating debt, July 1, was $259,-072.29, including $59,815 interest due on bonds. An effort was made in the spring to induce the stockholders to buy second-mortgage bonds enough to pay off the floating debt and buy some additional equipment, but they did not respond. The earnings of the road this year have been much smaller than was expected, owing to the general suspension of coal and iron mining. The stock amounts to about $1,950,000; there are $3,000,000 first-mortgage bonds and an issue of $1,000,000 second-mortgage bonds has been authorized, of which some $600,000 have been sold or hypothecated. The gross earnings for the year ending Mry 31, 1874, were $329,547, and the net earnings $140,731, or $1,407 per mile, or about two-thirds of the interest on the first-mortgage bonds. During the same year $510,537 was spent for construction and equipment, and $509,725 was received from stock subscriptions and second-mortgage bonds.

Illinois & St. Louis Bridge.

The first regular train passed over the bridge on the morning of July 16. It consisted of a locomotive and nine cars of the Indianapolis & St. Louis road, the cars being loaded with stone for the new post-office building.

Kansas Pacific.

The St. Louis *Republican* of July 18 says: "A number of officials connected with the Kansas Pacific Railway and the Union Pacific Railroad are here to confer in regard to prorating freight transported over both roads in accordance with the recent act of Congress. The gentlemen representing the Kansas Pacific are Edward S. Bowen, General Superintendent; S. C. Smith, Auditor; T. F. Oakes, General Freight Agent. Those representing the Union Pacific are E. P. Vining, General Freight Agent; A. J. Poppleton, Solicitor; S. H. H. Clark, Assistant Superintendent, and Thomas J. Kimball, General Passenger Agent, all of Omaha."

It is understood that the claims of the Kansas Pacific were fully presented, but that no final decision was reached.

Erie.

In a suit brought by the executors of John Arnot, of Elmira, N. Y., to recover interest and principal of certain bonds issued by the Boston, Hartford & Erie Railroad Company and guaranteed by the Erie, the New York Supreme Court has given judgment for the plaintiffs, the sum being $97,000. Under authority of this judgment the company's property at Elmira has been levied on. The case will be carried up to the Court of Appeals. If the decision is sustained, the Erie will be liable for the whole $5,000,000 of Boston, Hartford & Erie bonds which were guaranteed by it.

Dividends.

The Cleveland, Columbus, Cincinnati & Indianapolis Railroad Company has declared a semi-annual dividend of 4 per cent., payable August 1.

The Postal Car Question.

A Washington dispatch of July 20 says: "Correspondence has taken place between Mr. Hinckley, President of the Philadelphia, Wilmington & Baltimore Railroad, and the Post Office Department, with reference to an application for higher compensation for the movement of the post office cars over that road. Something is said about the determination of the company not to move such cars after the first of August unless their demand be complied with, but there is an impression that this question will be deferred until the newly-appointed Postmaster General shall have entered upon his duties. In

the meantime the railroad company will be officially informed by Postmaster-General Marshall that the law having fixed the compensation for the various kinds of service, the Department has no discretion in the premises, and therefore it cannot refer the question of compensation to an umpire, that course having been suggested by Mr. Hinckley."

Cuyahoga Valley.

It is stated that this company has arranged for the settlement of all points at issue with contractors, and the pay will be secured to the laborers. Steps have been taken to resume work, and the track will be put in readiness for laying the rails between Cleveland, O., and Canton this fall.

Peoria, Atlanta & Decatur.

This company seems to be in trouble again, the Illinois Central having levied on a large lot of ties to satisfy a claim of $4,000 for freight.

Texas Midland, Gulf & New Orleans.

This company was organized at a meeting held in Waco, Texas, July 6. Its officers state that a large amount of capital has already been secured, and that work will soon be begun.

Delaware, Lackawanna & Western.

The force in the shops has been cut down to the lowest point, and many engines and cars are laid up, owing to the depressed condition of the coal trade. Several of the company's best mines are idle.

Lehigh Valley.

Like the other coal carrying and mining companies, this company's business is just now very slack. The force in the shops and on the road has been cut down to the lowest point and many men have been discharged from the mines.

Pawtuxet Valley.

The rails are laid on this road, which leaves the Hartford, Providence & Fishkill at River Point, R. I., 11 miles southwest of Providence, and runs in a northwesterly direction 3½ miles to Hope Village. It passes through a thickly inhabited manufacturing country, there being seven stations on the branch, an average of one to each half mile. Trains will begin to run regularly about August 1. It is to be operated by the trustees of the Hartford, Providence & Fishkill under a five years' lease.

Cleveland, Columbus, Cincinnati & Indianapolis.

Arrangements are being made for the location of new shops at Brightwood, a suburb of Indianapolis.

Rockford, Rock Island & St. Louis.

The bill in chancery filed by the Union Trust Company to foreclose the first mortgage on this road has been dismissed by the Court. The grounds for the decision were that the necessary number of bondholders had not joined in the request to foreclose, as to former defaults, and that the bill was prematurely filed as to the default of February, 1873.

Ponagansett.

At a recent meeting of this company arrangements were made for the survey of the line from Providence, R. I., nearly due west to Danielsonville, Conn., a distance of about 25 miles. A committee was also appointed to consider certain proposals made by parties desiring to connect with the road at Danielsonville.

Freight Rates from Chicago to the Southwest.

A meeting of general superintendents and general freight agents of all the railroads leading to the Southwest was held in Chicago, June 16. It was decided not to pool the earnings, but to advance the present freight rates to Southwestern points 10 per cent.

Southwest Pennsylvania.

The contractor, John Snyder, has now several hundred men at work on the extension of this road from Connellsville, Pa., southward to Mount Braddock. Three miles of grading, to Dunbar, are completed, and work is going on rapidly.

Rutland.

Certain propositions have been made to this company by the Central Vermont, the lessees of the road, looking to a consolidation of the companies. A meeting of the stockholders was to be held this week to consider the propositions, the precise nature of which has not been made public.

Rochester & State Line.

The 25 miles of road from Rochester, N. Y., southwest to Le Roy is to be opened for business August 10. The ballasting and fencing is now being completed. Beyond Le Roy little is being done except to put up the fences where it is necessary to protect the road-bed. The grading and masonry of the road are substantially completed, and very little work is needed to make it ready for the iron. Negotiations are now going on for the sale of the first-mortgage bonds, and it is believed that this can be effected, so that work can be resumed soon and the road finished this year, though the time is now growing short.

Central Pacific.

It is reported that the Pullman Car Company is negotiating to again place its cars on the line from San Francisco to Omaha. If the arrangement is made, a large number of cars will be put on and will run through, avoiding the change at Ogden.

California Pacific.

A full and careful investigation of this company's affairs is, it is said, to be made by agents of the German bondholders, who are now in California for that purpose.

Chicago, Rock Island & Pacific.

The reduction in the passenger fares made in accordance with the new Iowa law is from 15 to 25 per cent. The following are the old and new rates to a few of the stations on the Iowa and Southwestern divisions from Davenport:

	New rates.	Old rates.
Atalissa, 33 miles	$0 99	$ 1 20
Iowa City, 54 miles	1 62	1 95
Grinnell, 119 miles	3 60	4 20
Des Moines, 174 miles	5 25	6 15
Council Bluffs, 310 miles	9 51	11 05
Washington, 75 miles	2 25	2 95
Sigourney, 103 miles	3 09	4 05
Centerville, 163 miles	4 89	6 42

The decrease in freight rates is from 30 to 40 per cent.

Kalamazoo, Lowell & Northern Michigan.

The stockholders of this company met in Lowell, Mich., July 9, and voted to change the gauge of their projected road to three feet. The reason given is that there was no prospect of securing money for a standard gauge road, and that if the road was of narrow gauge it might possibly be built.

New Bedford.

The stockholders of this company have authorized an issue of $400,000 first-mortgage bonds for the purpose of funding the floating debt and making certain improvements on the road.

Queen Anne's & Kent.

This road was sold under foreclosure of the first mortgage, July 14, and was purchased by C. W. Leavitt, agent for the bondholders, for $75,000. It is 26 miles long, from Centerville, Md., northeast to Massey's Junction, was built about four years ago, and is said to be in fair condition, with a light equipment. The first-mortgage bonds, the only funded debt, were $260,000.

Eastern Shore.

It is stated that a bill has been filed in chancery for an injunction against this company and the appointment of a receiver. The road is an extension of the Delaware Railroad from the Delaware line south by west to Crisfield, Md., and is 38 miles long.

Flushing, North Side & Central.

The stockholders of the Flushing & North Side, Central of Long Island, Central Extension Whitestone & Westchester, North Shore, North Shore & Port Washington and Roslyn & Huntington Railroad companies met in New York, July 20, and, by a nearly unanimous vote, ratified the agreement for the consolidation of the different companies into one, which is to be called the Flushing, North Side & Central Railroad Company. The various lines have been heretofore either owned or operated under lease by the Flushing & North Side Company. The lines owned by the new company are as follows:

Hunter's Point, Long Island, by way of Flushing to Whitestone	11¾ miles.
Flushing to Great Neck	6¼ "
Flushing to Babylon	31 "
Garden City to Hempstead	2 "
Bethpage Junction to Bethpage	2 "
Total	53 miles.

It is moreover intended that the consolidated company shall extend the Great Neck line eastward some 25 miles to Northport, with a branch of six miles from Manhasset to Sands' Point. The consolidated company owns all the Long Island lines outside of the South Side and Long Island Railroad companies' systems.

Chicago & Canada Southern.

Officers of this company say that arrangements are being made which will secure the speedy completion of the line to Chicago.

Brunswick & Albany.

Holders of first-mortgage bonds of this company are notified that the dividend due to bondholders not joining in the purchase of the road will be paid after August 1, and they are requested to communicate with Mr. J. F. de Neufville, No. 18 Exchange place, New York.

The litigation in the case of this company has been finally concluded. All the minor suits have been disposed of, and the title deeds to the purchasers and present holders have been finally ordered to be executed by the Court.

Richmond & Trans-Allegheny.

Elections have been held in the Counties of Campbell, Floyd, Tazewell and Powhatan, Virginia, on the question of subscribing to the stock of this company, and in each case the vote has been against the subscription.

New York & Canada.

The rails are all laid on the southern section of this road, from Whitehall, N. Y., north to Ticonderoga, 24 miles. The road is being ballasted and is to be opened for travel August 15. From Ticonderoga north to Port Henry, 17 miles, the road is already completed, that section having been part of the Whitehall & Plattsburg road, which was bought by the New York & Canada Company, so that 41 miles of the road northward from Whitehall are now completed. Work on the Lake George Branch is progressing, and it will probably be ready for use next month.

New York & Oswego Midland.

The Utica (N. Y.) *Herald* says: "Extensive preparations are making to repair the road-bed, trestles and bridges along the entire line of the Midland. Operations have already begun in many places, and it is intended to put the road in good condition to accommodate the increasing traffic and fall travel. Many portions are to be entirely rebuilt. A hundred tons of new rails are now at Norwich to be used between that place and Oneida."

New York Central & Hudson River.

The trouble with the farmers at Port Byron, N. Y., has been settled for the present. The third and fourth tracks are being laid on the company's property without taking any additional land for the purpose. This makes it necessary to leave a very steep bank.

Much trouble has been given by a break in the Athens Branch, caused by a sinking of the road-bed. The break is 500 feet long, and at last accounts 1,200 car-loads of gravel had been dumped in it without effect, the gravel sinking as fast as put down.

Baltimore, Pittsburgh & Chicago.

A temporary bridge has been put up over the Maumee River at Defiance, O., and track is being laid west from that point. Gangs of tracklayers are also at work in Marshall and Laporte counties in Indiana, and work was to be begun this week both eastward and westward from the crossing of the Cincinnati, Wabash & Michigan in Kosciusko County. The grading will, it is expected, be all completed by the end of August and the bridging before that time. Four steam shovels are in use supplying the ballasting trains, which follow the tracklayers as closely as possible.

Lak Shore & Michigan Southern.

At a meeting of the Executive Committee of the board of directors, held in New York, July 22, the following statement was presented by the Auditor, for the six months ending June 30, 1874.

Earnings		$8,674,839
Operating expenses (including cost of steel rails, substituted for iron), and taxes (66 per cent. of earnings)		5,608,993
		$3,065,846
Interest, leases and dividend on guaranteed stock	$1,380,000	
Discount on bonds sold	190,000	
		1,570,000
Leaves		$1,495,846
Equal to 3.025 per cent. on capital stock.		

The above amount has been expended for the following purposes:

On construction	$263,770	
On equipment	626,686	
		$890,456
All this was under contracts made by the previous administration prior to June 30, 1873, which contracts are now all closed.		
For payments on floating debt		605,390
		$1,495,846
The present floating debt is		$2,100,000

The reduction therein since January 1, 1874, other than by earnings, as shown above, was from proceeds sales second-mortgage bonds.

The committee resolved that it was not for the interest of the stockholders that the bonds should be sold at a sacrifice, or that the debt should be too much increased, and therefore it was not expedient to declare any dividend at the present time. In view, however, of the improvement in the company's affairs and the fact that it is not intended to engage in any new enterprizes, it is not believed that it will be necessary to pass another dividend.

Contrary to current Wall street reports, the question of a lease to the New York Central was not mentioned at the meeting.

Claims for Damages.

The following is probably a sample of the way in which many claims against railroad companies are made up. It is from the Hartford (Conn.) *Courant* of July 11, which says: "On the night of June 17 the steamboat train struck an ox belonging to Charles Mather, at Mather's Crossing, just north of this city. The animal was picked up and dragged into a neighboring lot, and left there, supposed to be dead. The next morning Mr. Mather, having some plowing to do, went to this field and yoking up his cattle did the work. Returning to the house he took up the *Courant* and read that the steamboat train had killed an ox near there, and a careful study of the case convinced him that it must be his ox. He repaired to the lot for inspection and discovered the scars which during the morning's work had escaped his notice. He has filed with the railroad company a claim for damages.

Syracuse Northern.

The road is now in charge of the officers of the Rome, Watertown & Ogdensburg Company, which has substantially secured control of the road. The second and third mortgage bonds which are now owned by that company and the Delaware, Lackawanna & Western have been placed in the hands of Dudley P. Phelps, as trustee, with instructions to collect the 18 months interest now due on them, or in default of payment to foreclose the mortgages at once. The latter course will probably be taken and the company re-organized, as it is not at all likely that the interest will be paid.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

Report of the Committee on the Form, Weight, Manufacture and Life of Rails.

[Concluded from page 270.]

The committee, as now advised, is of opinion that the patterns shown in the plates annexed, Nos. 1 and 2 for iron, 3 for steel and for 4 either first-rate iron or steel, the weights being respectively 62, 50, 53 and 56 pounds to the yard, all formed according to the foregoing principles, are substantially of the right form and proportions, unless the machinery is extravagantly heavy. Many thousands of tons of the 1st, 2d and 4th of these patterns, and many hundred of the third, have stood the test of several years' experience under a heavy traffic, especially on the different roads between Baltimore and New York. The corners, at the bottom and outside of the head, should not be so much as in the first four of these patterns, but the sides and bottom of the head should be brought very nearly to a sharp edge, as represented by the dotted lines. This would give greater wearing surface on the sides of the head, and greater bearing surface for the fish-plate, and would not increase the weight one-fourth of a pound per yard, or less than 0.4 ton per mile.* †

Mr. O. Chanute, Chief Engineer, Erie Railway, and member of the committee, proposes to adopt the form No. 5 for the Erie Railway.

The committee cannot see any definite relation between the proper weight of a rail and the weight of a wheel rolling over it. Of course the rail, both when new and when fully worn, must be strong enough to carry the weight between the most distant actual supports, and to distribute that weight among adjacent supports. As this depends on the residual part of the rail, there is, within certain limits, a sort of rule-of-thumb relation between the weight of that part and the weight on a wheel. But if patterns or materials differ widely, even that relation fails. That most important to consider is, between the weight on a wheel and the hardness, elasticity and breadth of the metal in the head. The proper relation of the consumable part of the rail is not with the weight on a wheel, but with the amount and mode of the traffic. The relations of breadth of base are with weight on rail and amount and hardness of timber under it.

As the weights of different parts of the rail should be adapted to different purposes, and so follow different rules, the parts should not be increased proportionally, but each according to the duty it is to perform. Nearly as strong a rail is required for a light as for a heavy traffic, with the same machinery, but it would be folly to put on as heavy a head for a light traffic road as for a heavy traffic. A poor rail gives out by coming to pieces, a good one by wearing down the head; neither is cured by general increase of weight. If our ties were always sound and solid and their surfaces in the same plane, the lightest rails in common use would be sufficient for strength and stiffness. But this is not always the condition, and the frost makes it worse by heaving the road-bed unequally.

Supposing the actual supports to be 5 feet apart or under, the rails represented in the diagrams are sufficient to carry the loads. According to more than 100 trials, made under the direction of the Chairman of the committee several years ago, with rails on supports 15 feet apart, the deflections of these rails were as follows: of the 62 pounds iron rail, 1.25 inches, with 4,400 pounds center load; of the 50 pounds iron rail, 1.57 inches, with 3,500 pounds, and of the steel, shown by diagram No. 4, 1.44 inches, with 3,800 pounds. The calculated elongation of the bottom film of the rail was in each case one fourteen-hundredth. In every instance the deflections continued to increase in proportion to the weights beyond those here given. The great distance between supports, of course, caused the twists and unsteadiness and lateral bends of the rail to show a worse result than if the supports had been nearer together. With actual supports 5 feet apart, the rails should safely bear center loads as follows: the 62 pounds rail, 13,200 pounds, with deflection of 0.14 inches; the 50 pounds rail, 10,500 pounds, with deflection of 0.17 inches, and the 56 pounds steel rail, 11,400 pounds, with deflection of 0.16 inches. Occasional weights much heavier could be carried without sensible injury. For the partially worn rails, the stiffness being less, the distance between actual supports would in most cases be diminished by enabling the rail to bend down to an intermediate support. But a more important evidence that these rails are strong enough is, that after a heavy traffic for several years they do not break, whether new or with the head fully worn. As the actual bearings and other data for an imperfect or frost-heaved track are unknown, not calculation but experience must decide what strength is sufficient.

Our rails do not give out for want of strength, but from injury to the head, not always perceptible to the eye. After a certain amount of such injury, additional strength postpones but does not prevent the destruction of the rail. It is better to prevent destruction by a little more and especially by a little better metal in the head, than merely to postpone it by much more metal below the head.

The really important inquiry is, what is the relation between

*For some particulars of experience with rails of the first four of these patterns, the committee refer to the annexed memoir contributed by their Chairman.

†Mr. Sayre has slightly beveled the upper part of the head in the rail shown in No. 6. This makes weight and cost about one per cent. less than if the sides were carried vertically up, and consumable area, and therefore endurance, three per cent. less. His object is to save the flanges of the wheels. The committee is not prepared to give an opinion on this feature.

the size and elasticity of, and the weight on a wheel, and the width, hardness and elasticity of the top of the rail.

Experiments made by Mr. Chanute show that a newly-turned driving-wheel, 5 feet in diameter, bears upon a rail surface only about one-fourth of a square inch. If, therefore, the weight on such a wheel is 10,000 pounds, the static pressure on the rail surface in contact with it is about 40,000 pounds per square inch; the dynamic pressure is still more. If the metal is so soft as to crush under this weight, as most wrought iron does, the top of the rail must not only be disintegrated so as to be easily wiped off by abrasion, but it must be expanded and elongated, a permanent longitudinal strain must take place, tending to tear apart the lower part of the head and all below it, and if it is not soon worn out, ultimate breakage must ensue. Increase in weight at best only postpones this breakage for a short time. Many rail-tops are actually elongated one-fourth inch.

As the crushing and consequent expansion of the metal extends but a short distance below the surface, any additional metal put in to counteract the strain should be put, not into all parts of the rail proportionally, but into the head, where it answers other important purposes.

A weight of 5,000 pounds, on a wheel 30 inches in diameter, probably causes very much more than half the pressure per square inch that is caused by 10,000 pounds on a 5-foot wheel. And the same weight on the same sized wheel, with the wheel or rail or both highly elastic, gives much greater surface of contact, and therefore less pressure per square inch, than if both were inelastic.

When the weight on a square inch area of rail surface reaches a certain point, a small addition to it increases the damage many-fold. Increase of width of head tends somewhat to remedy this; but a general increase in proportion to the weight of the wheel would do very little good. We, therefore, consider that no rule fixing the relative weights of load and rail should be adopted, except within very moderate limits for rails of the same pattern, kind and quality. This would be so local and limited as to be of no general use. As an increase of weight in the stem and base may cause too great rigidity, and thus diminish endurance both by increasing wear and fracture, any such rule is liable to be not merely useless but mischievous.

The committee is, as yet, unprepared to go into detail on the manufacture of rails. We remark that the manufacture has so improved in this country that patterns formerly inadmissible on account of the difficulty of rolling and risk of defects, and difficulties in cooling, are now readily produced.

A few general principles, already familiar, may be briefly enumerated. The top surface should be very hard, and if possible elastic, and made of such materials and in such manner as to be uniform, especially where heavy machinery is used; the base should be of strong and, if possible, slightly ductile metal, the cooling and straightening so managed as to cause no permanent strain of one part of the rail against another. A judicious increase of 10 or 15 per cent. to the cost of ordinary rails would double their value. But this rail purchasers will not often pay, and rail-makers have no encouragement to put on the additional work.

For testing rails the drop and the dead weight have often been used too exclusively. They test the rail only as a beam, and the metal only as to brittleness and strength. In England, where strength is the controlling consideration and where the rails are double-headed, the drop may be the best test. But here, where the rails do not give out from weakness but from wear, and where a certain amount of flexibility is conducive to the longevity of the rail, and where there is only one head, it is not a sufficient guide, except in comparing different rails of the same kind and pattern. A rail of light head and heavy base will give the best test with the drop, but it will not last so long as a rail with a heavy head and light base. The 56 pounds steel rail, diagram No. 4, is not so strong or stiff as the 62 pounds iron rail, diagram No. 1, and will not give so good results with the drop, but it will last ten times as long. Of course, we would not reject it as one of many tests. Reported tests commonly give us permanent set. What we really want is not the amount of set some weight or blow gives, but how great the weight or blow can be without any set at all.

Many years ago the Chairman of the committee adopted the test of hammering the rail to destruction. Perhaps 40,000 tons were tested (by specimens taken at random) in this way; and the experience is, that the number of blows on any kind and pattern of rail very closely measures the lifetime of that rail as compared with others of the same kind. It fully discloses the defects of the rail, as brittleness, softness, bad welding, lamination, etc. This, however, does not give the relative endurance of iron and steel, as it probably would if each was destroyed only by honest wear. Steel lasts many times as long as iron, not only because harder, stronger, more elastic and homogeneous, not coming to pieces, but perhaps mainly because as yet the weight on its surface is not great enough to crush it; whereas the weight on the same surface of iron, being too great for the material, crushes and destroys the fibre.

As most tests are related to the mode of manufacture, it is best to defer their consideration till the manufacture is considered. We only remark that the "durometer" is advantageously used to test the hardness. Iron rails give out very often from unequal hardness in the head, which makes it wear down in spots. This instrument can be used to detect any such inequality.

"The endurance of rails" is so dependent on their kind, quality and form, and their foundations and splicing, and on the grades, curves, etc., of the road, and on the speed of the trains, and size and weight on wheels, no definite average numerical results can be given without a much fuller response from the different railroads than we have yet obtained. We shall hereafter give some particular results of experience on this point. The duration of a rail is as indefinite as the value of a horse or the size of a piece of chalk. Some of the early rails were in use 25 or 30 years, while new and larger rails laid in the same track during part of the same time gave way in two or three years. Perhaps the light hammering of early times actually increased their endurance. With heavy machinery and high speeds a rail might carry 1,000,000 tons; with very light machinery and moderate speeds the same rail might carry 10,000,000 or 20,000,000 tons.

Of course the means of increasing endurance, besides increasing the sectional area of the consumable part of the rail, are better metal, good road-beds, moderate speeds and moderate weights. As other than engineering considerations often control the weights of machinery, the present excessive weights must be accepted as fixed.

One obvious remedy, though only partial, is to increase the width of the top of the rail, so that, the surface of contact of each wheel being greater, the pressure per square inch shall be less. If the weight on a driving-wheel is 10,000 pounds, and its area of contact with a rail-head 2.1 inches wide is one-fourth square inch, the pressure will be at the rate of 40,000 pounds per square inch. But if by increasing the width to 2.8 inches the area of contact is increased to one-third square inch, the pressure will be only 30,000 pounds per square inch. The damage done to the rail in the former case must be a great many times as much as in the latter.

Another obvious means of promoting endurance is to ballast the road with stone broken very much smaller than is customary in this country, and cover 30 per cent. or more of the span with ties about 7 inches thick, and not less than 8 feet long. The length of ties does not depend mainly on gauge, but on weight and bed. In some soils 9 feet lengths are required not to slide. Good ballast, in most situations, can be put on for one track for $2,000 per mile. If the rails will last four years with poor ballast, they will probably last five with good. Experience has sometimes shown much more than that difference.* If the cost and inconvenience of a renewal is $4,000, the present value of renewals each four years forever with money at 7 per cent. is $\frac{4000}{0.317} = \$12{,}620$; each five years $\frac{4000}{0.411} = \$9{,}732$. The difference, $2,888, is nearly 50 per cent. more than the cost of ballast. Besides the maintenance of the road-bed so ballasted is next to nothing; that of the unballasted or badly ballasted is very considerable.

The last point on which we are called upon to report is "the breakage of rails." We shall not dwell on such well-known causes as ties too far apart, rotten or uneven, want of good ballast, road-bed yielding unequally under the weight, depressions on the top of the rail, especially at the ends, lateral angles at the joints, or sharp curves approximating angles, punching, slotting and bad joints, nor shall we refer to obsolete appliances, such as chairs, etc. Nor shall we do more than refer to the too great rigidity of rail by which, as before pointed out, their liability to break is increased.

We call attention again to the elongation of the top of the rail by too great weight on a wheel in proportion to the bearing surface and the hardness of the metal, by which a permanent strain is created on the rest of the rail, perhaps gradually snapping the extended fibres or somehow weakening the metal, resulting in ultimate fracture. We also repeat that this is partially remedied by greater width of the top of the rail.

But why do rails break in winter especially?

1st. Because the material is, as most of the committee think has been proved, really more brittle in very cold weather. According to experiments reported by Sandberg, specimens requiring a drop to fall 39 feet to break them with the thermometer at 84°, were broken with the same drop falling 11 feet with the thermometer at 10°. Different kinds of iron and steel vary very much in this respect. Steel, though more elastic, does not wire-draw like iron. Iron does not wire-draw so much when cold. But it may be questioned whether the limit of elasticity in iron or steel is lowered by cold. If it is not, then cold alone would not endanger the rail, but inordinate strain must be an essential condition of fracture.

2d. The road-bed heaves irregularly, causing the rail to bear on few points far apart.

3d. The road-bed being frozen hard becomes inelastic; and also high points are not lowered to the level of other supports by the weight.

4th. The top of the head, being elongated, and a permanent longitudinal strain thus created, co-operates with the other causes in producing fracture.

5th. Insufficient allowance for contraction by cold may cause a longitudinal tension acting against the fish-bolts.

From a report on this subject from Mr. Chanute, it appears that on a Western railroad there had been no breakage for 10 years after the rails were laid, then 200 or 300 in one winter, and then over 5,000 the next winter, showing that by use the rails became more breakable.

Our last duty is to give our views of the comparative value of steel and iron rails. While steel rails as we get them are tolerably uniform in quality, iron varies so much that no comparison can be made except of particular qualities or of averages of qualities widely different. We can as yet do little more than give the results of our own experience. In so doing we shall not only compare steel and iron, but also the effects of some different circumstances on the duration of both.

It seems probable that the best iron, if homogeneous and the head of uniform hardness, so as to wear off evenly, like steel, would, with machinery of moderate weight, wear a third or even half as long as steel. The Chairman has found that his 62 pounds iron rail, after carrying about 14,000,000 tons gross load, has worn off only about 25 per cent. more than the steel rails on the same track and under the same circumstances. Probably it will not wear so when the top crust is worn through. But owing to want of homogeneousness and uniformity the iron scales, splinters, laminates, or somehow disintegrates or mashes in spots before it wears out.

In 1864 some steel rails were laid down at Wetherly, on what is now part of the Lehigh Valley Railroad, on a steep grade where there is constant drilling twelve or fifteen hours a day. A section of the only rail yet taken out after nine years and seven months wear is shown in diagram No. 29—the dotted line representing the probable original top. If that was the top the head is worn down three-tenths inch, and 9.39 pounds of metal per yard worn off by what is supposed to be equivalent to 40,000,000 tons freight or 100,000,000 tons gross load. The other rails are expected to last two years longer (in all twelve), and so to carry the equivalent of about 50,000,000 tons freight, or 125,000,000 tons gross load. If the stem had been thinner the wear would probably have been less. Iron rails in the same situation averaged four months, so that the steel seems to be thirty-six times as durable as the iron.

The 62 pounds iron rails before mentioned may carry 12,000,000 tons of coal with the slow speeds on the Belvidere Railroad. Rails in other places of fair ordinary quality carry from 2,500,000 to 6,000,000 tons freight, or 4,000,000 to 15,000,000 tons gross load, according to weights, speeds, grades and other circumstances.

A steel rail may last five or ten times as long as a really good iron rail, fifteen or twenty times as long as those that pass for good, thirty or forty times as long as the common run, and fifty or even hundred times as long as many rails made ten years ago, or since imported from the cinder heaps of Great Britain.

From observations made under the direction of the Chairman, of which diagrams Nos. 7 to 17 are specimens for steel, and Nos. 18 to 28 for iron, it appears that 1,000,000 tons of freight or its equivalent, equal to 2,500,000 tons gross load, have worn off the steel from 0.14 to 0.62 pounds per yard, averaging 0.30 = 0.47 tons per mile, and have worn off the iron from the 62-pounds rail rolled at Bethlehem from 0.27 to 0.69 pounds per yard, averaging 0.38 = about 0.6 ton per mile. The rails have been laid from four to seven years, most of them six years. It will be seen from the diagrams that in most cases the head is worn off as much on the side as on the top, even on straight lines. This is owing in part to the gauge of the foreign cars being two inches narrower than that of the road.

If the heads of these steel rails can be safely worn down one-half inch and one-fourth inch from each side, those on straight lines and under other favorable circumstances ought to carry 100,000,000 tons of freight, those on the worst curves 20,000,000, the average 50,000,000, equal to 125,000,000 tons gross load. But for the difference in gauge between the cars and the road the endurance would probably be much greater. On straight lines the wear on the top seems to be only one-hundredth inch for 125,000,000 tons of freight, that should require 62,000,000 tons to wear the head down one-half inch.

Probably steel rails can at the present moment be purchased for $9,000 per mile, which last 10 times as long as the best iron that can be had for $6,000 per mile. The commercial value of the iron (measured by price) will then be two-thirds that of the steel, its intrinsic value or capacity for usefulness (measured by endurance), one-tenth that of steel. Its economic value will depend on combined capacity and opportunity for usefulness (measured by endurance and traffic), and the interest chargeable against it.

Let I represent the cost of the iron = 6,000, S that of the steel = 9,000, L the loss on each renewal of the iron, say 4,000; L^1 the loss on each renewal of the steel, say 5,000. Let a be the rate of accumulated interest (at 7 per cent.) for the interval between the renewals of the iron, and a^1 that for the intervals between the steel. Then to make the iron and steel equally economical.

$$I + \frac{L}{a} \text{ should equal } S + \frac{L^1}{a^1}.$$

If iron will last 10 years under the traffic on the road to be provided for, and steel 100 years, then the cost of iron and its perpetuation will be

$6{,}000 + \frac{4{,}000}{0.99} = 10{,}041$; of steel, $9{,}000 + \frac{5{,}000}{971.8} = 9{,}005$, and the present value of the difference in favor of steel will be 1,036. At 12 years it is nearly equal, over 12 iron is most economical, under 12 steel is most economical.

But it may be economical to use iron temporarily, while traffic is light, and replace with steel when traffic becomes heavy. Under no circumstances can it be economy to use a very heavy iron rail (say 80 pounds to the yard), for a light steel rail would cost less and last longer. It makes little difference whether a steel rail will last one-half century or forever. The present value of renewals every 50 years forever is only $\frac{5{,}000}{30.19} = 165$ or less than 2 per cent. on the cost of the rails.

The members of the committee have endeavored to dissect the subjects referred to them, and present the points separately, so that those of the Society and others may give facts or opinions on points within their observation, before the Committee are called upon for a final report.

ASHBEL WELCH,
JOHN GRIFFEN,
OCTAVE CHANUTE,
M. N. FORNEY,
I. M. ST. JOHN,
} Committee.

MEMOIR BY MR. ASHBEL WELCH.

During the year 1865 the task presented itself to me of devising or selecting suitable forms of rails for the system of railroads occupying the central part of the State of New Jersey, between Philadelphia and New York, of which I was the executive officer as well as the engineer. I proposed to use three classes of iron rails, one for main lines with heavy traffic, one for branches with light traffic, and one for sidings but little used, and one class of steel rails, of course for main lines. The result of the consideration then given to the subject was the adoption of principles by which the forms of rails should be determined nearly identical with those set forth in the report to which this memoir is appended, and patterns were adopted conformable thereto.

A 62-pounds rail pattern was adopted in 1865, afterwards slightly modified by less rounding of the corners of the head. This pattern, so modified, is shown in the annexed diagram marked "No. 1," height 4¼ inches, base 4 inches, stem one-half inch thick, radius of sectional curvature of top 12 inches, inclination of bearing surfaces for both bottom and top of the fish plate, 14°. Many thousand tons of rails of this pattern, rolled principally by the Bethlehem Iron Co., were used under my own direction, and, so far as I can learn, no American rails have endured better, most not so well. Diagrams Nos. 18, 19, 20, 21, 22, 23, 24 and 25, show how they are worn in 6 years, carrying 6,000,000 tons freight, or 15,000,000 tons gross load. After an experience of eight or nine years with such rails, under a heavy traffic, with heavy machinery and high speeds, after much inquiry, I have not been able to find that the half-inch stem has ever compressed or bent sideways, or the head or base has cracked off, or suffered in any way from the sharp re-entering angle with the stem, or that the rail has ever given out, except by wearing, crushing, scaling, splintering or laminating at the top. Substantially this form is now being adopted by neighboring engineers in this country, who at first strongly objected to it. I made one decided mistake in this pattern, by not having the outer bottom corners of the head sharp enough; or, rather, I yielded too much to the general feeling against such an unsightly thing as an angular head.

Where chestnut and other soft ties are used, unless the wood is very elastic, the base of this rail should be increased to 4½ inches.

Diagram No. 2 shows the 50-lb. iron rail I adopted for branch railroads; height and base each 3⅛ inches, stem 15-32 thick, head 2⅝ wide and 1⅛ deep. More than 30,000 tons of this pattern, rolled by the Allentown Rolling Mill Co., are in use on different roads, and do good service.

Previous to 1867 the steel rails laid in this country, copied from the iron rails then in use, were unnecessarily heavy, and so proportioned that much of the metal did no good. The forms in use for iron rails were calculated not so much to prevent their destruction by wearing out as by coming to pieces. Believing that there was no danger of this latter mode of failure in a steel rail, and that a very thin stem and base would give sufficient strength, I determined to try a pattern in which all the metal possible should be put into the head, and as little as possible anywhere else. This pattern, intended as an experiment to give the principles I had adopted an extreme test, is represented in the diagram marked "No. 3," height and base each 4 inches, head full 2¾ inches wide and 1¼ deep, radius of sectional curvature of top of head 12 inches, stem 7-10 thick, base 3-16 on the edge, and its upper surface rising at an angle of 14° (same angle as under side of head), weight 53 lbs. to the yard.

After considerable negotiation with Naylor & Co., during the early part of the season of 1866, I gave them the order on August 14 for 200 tons of steel rails of that pattern, to be rolled by John Brown & Co., at Sheffield. After much hesitation and unsuccessful effort on their part to get the pattern modified, and the lengths reduced below 30 feet, the rails were finally rolled by them without much difficulty, stood an unexpectedly good drop test (tested, as I understood at the time, by Kirkaldy, at London), and were laid in the spring of 1867 at points on the main lines of the railroads above referred to, where it had been found that rails were destroyed most rapidly.

The severe usage to which these rails were subjected, without the slightest injury, soon made it evident that they were strong enough, and several hundred tons more of the same pattern were laid down in 1868 on the main line, between Philadelphia and New York, in places where rails were worn out most rapidly. One point where they were laid was in Bergen Cut, a mile or two from the Hudson River, where the curves are very sharp and the speed high. Probably 3,600,000 to 3,800,000 tons of gross load per annum have since passed over each track laid with these spindle-shanked rails at that point, equivalent to 9,000,000 to 10,000,000 tons of freight in the 6 years.

After frequent, including very recent, examinations of the rails of this pattern, I cannot find that one rail has ever broken, although many hundreds of other rails, including some 67-pounds steel, have broken on the same roads since these were

* Many years ago the Chairman of the Committee ballasted a mile as follows: The loam at sub-grade was rolled and leveled till even, slightly rounded and uniformly hard, then a thin stratum of fine gravel put on to prevent the loam from rising between the broken stones, then a stratum of ordinary ballast 6 inches thick, then very fine ballast 9 inches thick, in two courses. Each stratum and course was thoroughly rolled before the next was put on. For 10 years it is not supposed a dollar was spent on this mile, except to watch it. Rails and ties are supposed to have lasted 40 per cent. longer than in other places.

laid. The only injuries I can find to the stem or base are: one base cracked, and the bases at three joints on rotten ties bent up for a very few inches. In many places where these rails are laid the road-bed is not a good one. The rails with thinnest stems wear best.

On applying accurate complementary templets to these rails, no stem has been found compressed or bent or deflected from the perpendicular. The templets would show a deviation of less than one-hundredth inch. Except the wear on the heads, the rails are apparently as good as when first laid, some six and some seven years ago. The accompanying diagrams, Nos. 6, 8, 10 and 12, show how and how much the heads have worn. On the sharp curves the wear on the top of the head of the outer rail is three or four times as much as on straight lines, the wear on the side of the head increasing the whole loss of metal to four or five times as much as on the straight line, except where there is much stopping and starting. As these rails were in all cases laid in the worst places, the wear is much greater than it would average on a whole road. In those places good fair iron rails, as rails went in those days, wore out in a year. On the Belvidere Delaware Railroad, where the trains commonly take 750 tons of coal, at a speed of eight miles per hour (the weight on each driver being under 10,000 pounds), and the foundation is good, the wear on the top of the rail is sometimes not over one-hundredth inch for 2,000,000 tons of coal or its equivalent; while at Bergen Cut, where the radius of curvature is under 600 feet, the loss of metal from the top and side of the head is full six times as great for an equivalent amount of traffic. In the former the capacity of this 53-pounds steel rail is probably 80,000,000 tons of coal, or 200,000,000 tons gross load, in the latter 30,000,000 tons gross load.

These rails having behaved so well, I adopted the pattern for the system of roads in my charge; slightly modifying it however, by putting a little more metal into the base and stem, making the latter 15-32 thick, and increasing the weight to 56 pounds. This is shown in diagram No. 4, and was partly a concession to general opinion, especially to that of President Hinckley, who adopted this pattern for the Philadelphia, Wilmington & Baltimore Railroad, partly to facilitate the manufacture, but especially to be on the safe side. As the original 53-pounds pattern has given just as good results as the other, I would adopt it now in preference, except where the machinery is very heavy, or the ties bad.

Several hundred miles of track laid with steel rails of this modified (56-pounds) pattern have been in successful use under a heavy traffic, with high speeds, from three to six years; especially on the roads between Baltimore and New York. I cannot find that more than two or three of these rails out of 7,000 or 8,000 tons laid under my own direction have been broken or removed from the track.

This pattern, regarded at first by all who saw it with surprise and disapprobation, has been growing in favor, and with slight modifications extensively adopted. Those who have since adopted substantially the same pattern may have been led to it without any knowledge of mine by the same course of reasoning that I followed.

For reasons elsewhere given, the corners on the under side of the head ought to have been less rounded. With ties of soft wood (unless very elastic, like cypress), the base should be 4½ inches wide, or even wider.

Misled by a high foreign authority, I at first used too short fish-plates, only 14 inches long, the ends of which slightly indented the shoulders of the rail. I afterwards used fish-plates 28 inches long. The flat slopes adopted for the bearings of the fish-plate prevent any such tendency to move outwards that the bolts ever break or the nuts work loose. I put small leather washers under the nuts, and though tried periodically, they are sometimes not tightened for many months or even for years.

I understand that some railroads are now using an iron rail of the pattern shown in diagram No. 4. If the metal is thoroughly welded, it will do well.

As the foregoing experience with very slender rails differs widely from what was generally expected, I submit it for the information of the Society.

DISCUSSION ON THE REPORT.

MR. HORATIO ALLEN.—In listening to the report just read, I have wished very much that we had in this country the good old English custom of saying "hear, hear." Surely, then, many present would have been prompted thus to manifest their approval. Although all may read the report in print, those who have traveled a long way to attend this Convention must rejoice that so valuable a paper has been pressed upon their attention and memory by one of such experience and ability. It is rarely a body of engineers listens to so much that is valuable as we have just done.

MR. ROBERT L. COOKE.—I understand this is only a partial report, and that the committee still has the matter under consideration. I move the adoption of the report, and that the committee be continued. (The motion was carried.)

MR. J. DUTTON STEELE.—I have been exceedingly interested in the report, and think the Society has great reason for congratulation that this important topic has been placed in so competent hands.

When the old fish-belly rail in the Liverpool & Manchester Railroad was abandoned, the matter was made the subject of scientific investigation in England, the result of which was the production of a rail pattern nearly like that recommended by this committee, and the adoption of which was prevented by the influence of the iron manufacturers.

About a dozen years ago a very large]_[shaped rail, 12 inches across the bar and 6 inches high, was in favor in England. The two rails forming the track, every 8 feet in length, were tied together with iron bars, and the ballast was put in so as to sustain them without ties or other supports. An English stockholder in the railroad of which I had charge at that time caused to be sent over to America enough of these rails to lay one mile of track, which was carefully done, and the ballast put in. The result was that at first it was one of the most perfect roads that I ever rode upon; there was hardly a jar or quiver; but in consequence of the lack of elasticity referred to in this report, the wear was astounding, and in six months the rails had to be taken up.

The double-headed English rail was intended to reverse. If I am rightly informed, one objection to this pattern not mentioned by the committee is, that the roll of the wheels on the head of the rail granulates or wears it so that fracture takes place immediately upon reversion. I have watched with some interest, as probably subject to similar influences, steel frogs when reversed, and find that they will not then withstand the wear.

MR. A. D. BRIGGS.—My own observation has led me to doubt very much whether low temperature is the cause of failure of rails in cold weather. It is a matter to which I have given much attention during the last few years. I have collected considerable information upon the subject, and so far as I am at present informed, *good* rails and *good* iron wheels are not weaker in a low temperature or more likely thereby to break than in a higher temperature. In Massachusetts it has been shown that few, if any, more rails or ties break in cold than in warm weather from temperature alone. I am assured the failures in cold weather are due instead to defective rail patterns, the quality of material, or the condition of the road-bed.

THE WEIGHT OF RAILS AND THE BREAKING OF IRON RAILS.

[Notes by O. CHANUTE, C. E., member of the Society, presented July 15, 1874.]

The Weight of Rails.—The writer has long entertained the opinion that the assumption of any fixed relation between the weight of a rail and the maximum load borne by one pair of wheels passing over it was misleading and fallacious. A simple consideration of the pressure on the surfaces in contact between the driving-wheels of the locomotive and the rails will make this apparent. If the wheel and the rail were both inelastic, the contact would be a line, and the pressure would be infinite. Being elastic, however, they both yield a little, and the contact becomes a surface.

Ten years ago, the writer took some pains to measure these surfaces, and then found them to average about ¾ of an inch across the face of the rail and about ¾ of an inch along its length, giving an area of 9-32 of a square inch, on which a weight of 9,000 pounds will exert a pressure of 32,000 pounds per square inch, 10,000 pounds a pressure of 35,555 pounds per square inch, and 11,000 pounds a pressure of 39,111 pounds per square inch. These experiments have recently been repeated upon the Erie Railway. Those which seemed most satisfactory were made by jacking up simultaneously both wheels of a pair of drivers, and introducing between them and the rails a sheet of thin tissue paper, underlaid by a black sheet of thin manifold copying paper. By lowering the wheels upon the paper, and allowing their full weight to rest thereon, a very good impression of the surfaces in contact was obtained.*

The following table are *static* pressures, and as ordinary wrought iron begins to crush at about 38,000 or 40,000 pounds to the square inch, the following weights when put into motion are pretty sure to smash down any material as soft as ordinary bar iron. While the maximum weight on the wheels, therefore, should undoubtedly govern the hardness of the *material* in the head of the rail, it has no relation to the *weight* of the rail, except so far as this results from its necessary form and proportion as a girder to carry and distribute the weight to the supports, and this again is modified by the distance they may be spaced apart:

Number of engine.	Diameter of driver.	Weight on driver.	Position of wheel.	Condition of wheel.	General size of impression.	Area in contact.	Pressure per square inch.
	ft. in.	lbs.			inches.	inch.	lbs.
388.	5 0	11,175	Right.	Worn.	7-16×¼	0.13	85 961
388.	5 0	11,175	Left.	Much worn.	2×3-16	0.42	26,607
482.	4 7½	11 358	Right.	Newly turned.	⅜×⅜	0.32	35.494
482.	4 7½	11,358	Left.	Newly turned.	7-16×¾	0.14	81,128
492.	5 0	11,912	Right.	Partly worn.	¾×7-16	0.36	33,089
492.	5 0	11,912	Left.	Partly worn.	¾×¼	0.35	34,034
384.	5 0	11,185	Right.	Partly worn.	¾×¼	0.32	34,953

If these premises be correct, it follows that the adding of weight to an iron rail, already sufficiently stiff to carry the load, would only insure its more rapid destruction, by making it too rigid to yield slightly under the wheel, and perhaps by preventing such slight deflections between the supports as is found admissible in practice, and which, by curving the rail to some assimilation with the wheel, probably increases slightly the areas in contact, and so diminishes the intensity of the crushing pressures. Hence we find that in many cases some light, shallow rails, with hard material in the head, thoroughly welded, have greatly outworn much heavier iron rails under the same traffic. Hence, also, railroads with a heavy traffic, requiring powerful locomotives, with 11,000 to 12,000 pounds per wheel, in order to haul maximum trains and keep down the expenses of their train service, really cannot afford to lay any but steel rails in their main tracks. Railroads with a moderate traffic, which cannot as yet afford to buy steel rails, and have from 10,000 to 11,000 pounds on their engine wheels, should stipulate for the hardest iron it is possible to place in the heads of their rails, with a due regard to perfect welding; while those with a light business would actually find it more profitable to sell any locomotives with more than 10,000 pounds per wheel than to have them crush and destroy the iron rails now laid in their tracks, before the growth of the country furnishes a remunerative business.

It is therefore suggested, as of more pressing importance to many of our American railroads, that they should preferably proportion their machinery to the rails now lying upon them than endeavor to adapt the rails to the machinery. In the building of new roads, the weight and character of the rails have been governed by financial rather than truly economical considerations. Railway presidents and directors have consulted the treasurer, rather than the engineer. The latter should therefore endeavor now so to have the engines proportioned as not to exert crushing strains on the rails.

As the first set of rails become worn out, and the traffic increases, the weight of the locomotives is sure to increase, and it is right that it should do so. Rates will be decreasing at the same time that the volume of business increases, and the expenses of train service will be assuming a larger proportion of the total cost of operating, so that it will be desirable to economize, and to diminish the proportion of cost of train labor, by increasing the size of the trains. This result is inevitable, and when this second period arrives, it would be a mistake to oppose an increase in the weight of locomotives to conform with modern practice, which then becomes both necessary and economical.

When this occurs, however, the weight upon the driving-wheels should govern the *material* in the rail rather than its *weight*, and endeavors should be directed to the selection of the best materials and proportions for the second set of rails, whether of steel or of iron, instead of looking to a mere increase of weight, which, as hereinbefore stated, may become a positive detriment. The weight of the rail will result from its form and depth, and it should be designed as a girder or beam, resting upon several supports, so as best to carry and distribute the loads on the wheels. The distance apart of the ties or supports will be governed by their cost, by the depth assumed for the rail, by convenience in tamping and repairs, as well as by the character of the soil, of the machinery and of the traffic. It may be stated in general terms that the best practice in this country seems to point to the laying of rails 4 to 4½ inches deep, weighing from 56 to 68 pounds per yard, upon ties spaced about 2 feet from center to center.

The following rules are therefore proposed as a substitute for that fixing the weight of rails as a multiple of the maximum weight upon a driving-wheel.

1st. Rails are to be designed as girders resting upon several supports, on the same principle and from the same general data as those now applied to bridges.

2d. Where locomotive driving-wheels are loaded to 11,000 pounds or over, the rails should be of steel.

3d. When from any cause it is not possible to provide steel rails for such weights, the material in the heads of iron rails should be the hardest it is possible to weld thoroughly to the body of the rail.

The Breaking of Iron Rails.—Sufficient attention has probably not been called to the age of iron rails, or rather to the amount of traffic which has passed over them, as affecting their liability to fracture in cold weather.

Some years ago the writer was in charge of the maintenance of way on a prominent Western railroad. About 71 miles of this had been laid in 1854 with an English rail of about 58 pounds weight per yard. It was pear-headed, and laid with wrought-iron chairs upon joint ties. During the winter of 1864–5, these rails, which had hitherto proved amply strong for the traffic and machinery, began to break under the trains, and some 300 of them snapped upon this division during the continuance of the cold weather. This breaking ceased when spring returned, and during the ensuing summer and autumn few or no breakages occurred.

The condition of the track, already much improved, compared with what it had been in former years, was made still better during the working season. About 15 miles were relaid with re-rolled iron, thus reducing the amount of old rails upon this portion of the road to about 56 miles; many new ties were put in, and great attention paid to the surfacing, draining and ballasting. Notwithstanding this, as soon as cold weather set in, during the winter of 1865–6, the rails began to break under the trains at a most alarming rate. Sometimes from 50 to 100 rails would be reported broken of a night, and about 3,400 rails snapped upon this 56 miles during the continuance of the cold weather. As most of these rails were 18 feet long, this amounted to about 5¾ miles of track, or over ten per cent. of the whole.

Immediate measures were taken to guard the safety of the trains. Passenger trains were slowed to a speed of 20 miles per hour, and freight trains to 12 miles per hour over this dangerous portion of the line. It was divided into patrols from three-fourths to one mile in length, and watchmen were put on night and day, to walk over the track after every train, to look out for broken rails, while the section gangs were held in readiness at all times to repair or replace any breakages. These mainly occurred over the shoulder ties, or those next to the joints, and about 20 to 24 inches from the end of the rail, although sometimes the rail broke into three or four pieces under the train. The precautions taken proved so effectual that after they were adopted only 72 trains went off the track (of which but one was a passenger train) on this portion of the road, and in every case the trains were thrown off by rails which broke under them.

The process seemed to be as follows: The rails broke under the engine, but this almost invariably passed over in safety, the car-wheels then successively loosened the broken piece of rail, until one of them threw it out of line, when the next wheel would go off the track and the train would be wrecked, generally towards its rear end. In the vast majority of instances (say 3,400 to 22) the broken pieces of rails were not thrown out of the track by the train which had broken them, or if so, only dropped out of line after the last car had passed, and were soon thereafter found by the watchman, when a new rail would be put in, or the pieces secured in place, so that the next train, which was flagged, could proceed in safety.

Most of the breakages occurred when the weather moderated after a very cold snap. A comparatively mild night, after two or three days of intense cold, always showed a large increased number of broken rails in the daily reports of the watchman. An increase was also shown when the weather turned from mild to cold, the predisposing cause seeming to be a change in the temperature, and consequently in the internal strains of the rails. As spring and warmth returned the rails gradually ceased to break.

It is almost needless to say, that during the succeeding season the whole of that 56 miles of track was relaid with new rails.

Incredible as this experience may seem, it is believed not to be singular. It is within the personal knowledge of the writer that an engine without a train, with a flat driving-wheel, broke no less than 163 rails, upon another Western railroad in running 30 miles, without getting off the track herself, and that some lines have recently had an experience very similar to that above described, as to the number of breakages.

It seems certain that after rails have been run over either a certain number of times or of years, they become much more brittle, and likely to break off square without warning. They may have proved to be sufficiently strong during the first few years after which they were laid, and then suddenly develop increased brittleness, and break in large numbers under the same class of rolling stock, and the same conditions of working as those which they have successfully withstood during previous winters. This has been partially counteracted on some lines by annealing repaired rails. For this purpose they have been roasted to a dull red heat, over fires made of old ties, and allowed gradually to cool, but the results have not been sufficiently satisfactory to warrant a continuance of the practice.

The reader will naturally conclude that these experiences tend to confirm the theories of so-called granulation or crystalization of iron under severe strains. That a very great reduction of its tensile strength takes place under repeated and severe vibrations is abundantly proved, but an inspection of the fractures of these rails did not lead to the belief that any process at all analagous to crystalization had taken place. A minute examination of the foot of the broken rails rather conveyed the impression of bright broken threads, while the heads presented a more granular appearance. If we consider that in the operation of rolling the original grains of the wrought iron were gradually lengthened into fibres, and that repeated tensions and vibrations would tend to break and separate some of these fibres, especially when a change of temperature had altered the internal strains in the rails, we will probably form very nearly an idea of what really took place. The fact that the greatest number broke upon a moderating of the weather, and the general position of the fracture over the first tie, back from the joint, led to the belief, that they probably first broke by tension in the head. The latter, having greater mass than either the foot or stem, would absorb heat and expand more slowly, and therefore would be in greater initial tension, especially in the night, when the counteracting effect of the sun's rays would not be present. A rail, being substantially a continuous beam resting upon a number of supports, would, on the passage of a load, have its top strained in compression between the points of contrary flexure between the ties and in tension over the supports. Hence the breaking over the shoulder ties upon a slight yielding of the joint.

If this theory be correct, it follows that not only must care be exercised in obtaining a hard quality of material for the head of iron rails, in order to resist crushing, that this material must weld perfectly to the plates beneath it to avoid lamination, but also that it must be strong iron and sufficiently worked to develop tensible strength, in order that the rail shall not become brittle in using. Curiously enough, the rails which have proved most liable to fracture within the experience of the writer have been of comparatively heavy section, and generally pear-headed. The most brittle he has ever known were a lot weighing 72 pounds per yard, originally laid upon the Portage Railroad of Pennsylvania and transferred to a Western line.

The rerolled rails made from those which had been taken up on the 56 miles which have been alluded to never broke. They had a very great surplus of strength, but they proved so soft that they were crushed to pieces in 3 or 4 years, while the original stock from which they were made had lasted from 10 to 11 years in the same track. In this latter case they evidently had been worked too much and tensile strength had been developed at the expense of hardness, so that the rails were no longer able to resist the crushing pressures of the driving-wheels.

* The experiment on engine 492 was made by substituting thin bank-note paper for the tissue paper, and that on engine 384 by wetting the rail around the area in contact with the wheel with a solution of sulphate of copper. The copper, being deposited on the rail and wheel, left a bright spot of iron untouched where the surfaces had been in contact. Neither of the latter experiments were deemed as satisfactory as those with tissue paper.